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Sci 120.40

THE GIFT OF

THE EDITORS OF

THE HARVARD ADVOCATE

(Class of 1873).

Received 15 May, 1875.

TRANSFERRED

HAR

THE

SCIENCE RECORD

FOR

1875.

A COMPENDIUM

OF

SCIENTIFIC PROGRESS AND DISCOVERY

DURING THE PAST YEAR.

WITH ILLUSTRATIONS.

EDITED BY ALFRED E BEACH.

NEW-YORK:
MUNN & COMPANY, OFFICE OF THE "SCIENTIFIC AMERICAN."

1875.

Sci 120.40

PREFACE.

THE present is the fourth annual volume of the SCIENCE RECORD series, and the back volumes having been reprinted, all can now be promptly supplied by the publishers. The series includes the volumes for 1872, 1873, 1874, and 1875.

The aim is to present in each year's volume concise notes of the most interesting, useful discoveries, and new facts, pertaining to Science and the Industrial Arts.

The large demand for these books is a gratifying indication of their usefulness, and encourages the publishers in their intentions to make the future volumes more full and valuable.

JOSEPH PRIESTLEY, DISCOVERER OF OXYGEN GAS.

(See Biography.)

SCIENCE RECORD.

CHEMISTRY AND METALLURGY.

THE CENTENNIAL OF CHEMISTRY.

THE year 1874 is memorable as the one hundredth anniversary of the discovery of oxygen gas by Priestley, and also of the announcements made at that time by other learned men of the indestructibility of matter, its subjection to analysis, weight, and measurement, and other principles upon which is founded the modern science of Chemistry.

The discovery of oxygen gas was made on the 1st of August, 1774. The only previously known gases were hydrogen and carbonic acid. How life was sustained, of what the air was composed, or what it was in the atmosphere which invigorated and maintained the physical energies of living beings, of what water was made and myriad other substances around us, were subjects in relation to which mankind had always remained in comparative ignorance. The discovery of oxygen was the key to the treasure-house of nature, whereby her wondrous secrets were to be revealed, and her hidden riches made useful to man.

Joseph Priestley, the discoverer of oxygen gas, was born at Fieldhead, near Leeds, England, in 1733. He was a man of unusual attainments, learned, active, progressive, and even radical, in almost every department of knowledge of his day. He was never satisfied with things as they are, but always aimed to reach something better. He studied electricity with Franklin, became a teacher, then a clergyman, was elected member of the Royal Society, was appointed chaplain to Captain Cook's second expedition, but the appointment was revoked before he sailed, on account of supposed errors in his religious views.

His progressive political ideas, leaning as they did toward democracy and republicanism, made him unpopular in Birmingham, his home, and in 1791 his dwelling-house was fired and destroyed by a mob, his scientific apparatus, library, and personal property destroyed, and his family separated. He wandered about for a while, despised by people of influence, shunned by his fellow royal members, regarded as a heathen by his brother clergy-

men, and finally, in 1794, determined to leave his native land, where he was treated with indignity and persecution, to find a new home with his relatives in America. He landed in New-York, June 4th, 1794. He settled in Northumberland, Pa., and there died, on the 6th of February, 1804, at the age of 71 years. He was the author of a large number of papers and works, independent of his many scientific contributions. Besides oxygen gas he discovered hydrochloric and ammonia gases, sulphurous acid, carbonic oxide, and nitrogen.

The one hundredth anniversary of Priestley's great discovery of oxygen was celebrated by the people of Birmingham, England, by the erection of a marble statue of the man in a prominent place in that city, accompanied by interesting public ceremonies. Professor Huxley was the orator of the occasion. On another page (see Biography) we give extracts from this oration; also an engraving of the statue. The frontispiece portrait is from a painting by the celebrated Gilbert Stuart.

In this country the celebration took the form of a meeting of American chemists at Northumberland, Pa., the adopted home of the great author. The original suggestion for this gathering was made by a lady chemist, Miss E. T. Capen, of the Boston, Mass., High School. But it was Professor H. C. Bolton, of Columbia College, N. Y., who issued the call, promoted and brought about the meeting.

The assemblage met on the morning of July 31st, 1874, in the Public School building of Northumberland, under the auspices of a local committee headed by Joseph Priestley, M.D., a lineal descendant of the departed philosopher. Professor Bolton was elected temporary Chairman; Professor Charles F. Chandler, President; Professor A. R. Leeds, Secretary. Col. David Taggart delivered an interesting address of welcome. Letters from eminent persons, unable to be present, were read. Telegrams were exchanged with Birmingham, England, where a statue of Priestley was at the time being unveiled by Professor Huxley, and Professor H. H. Croft introduced the business of the day by reading a paper on "The Life and Labors of Joseph Priestley," in which he rapidly but clearly traced Priestley's great life and works. Resolutions were adopted favoring a grand centennial celebration by the chemists of the world in 1876, at the time of the great exhibition in Philadelphia.

At the setting of the sun, the chemists, in company with a large number of visitors, were conducted to the cemetery where the remains of Dr. Priestley rest. A plain mar-

ble stone marks the pretty spot, which is elevated and commands an extensive and beautiful view. The following simple epitaph is engraved upon the stone:

TO
THE MEMORY OF THE
REV'D DR. JOSEPH PRIESTLEY,
WHO DEPARTED THIS LIFE
ON THE 6TH OF FEBRUARY, 1804.
ANNO ÆTATIS, LXXI.

Return unto thy rest, O my soul, for the
Lord hath dealt bountifully with thee.
I will lay me down in peace, and sleep till
I awake in the morning of the resurrection.

Standing uncovered, the large audience listened to an oration by Henry Coppée, LL.D., President of Lehigh University.

In the evening, Professor T. Sterry Hunt delivered an address on "The Century's Progress in Theoretical Chemistry."

On the following day, August 1, Professor Silliman read an essay on American contributions to chemistry, and various other papers on the history of the subject were given, and many interesting letters and other relics of Priestley were exhibited.

PARAFFIN.

AT a recent meeting of the Society of Arts, London, Mr. Frederick Field gave the following interesting information:

In pursuing his celebrated researches upon the tar obtained from the red beech, Reichenbach discovered in the ultimate portion of his distillates a white translucent substance, to which he gave the name paraffin (from *parum* and *affinis*), owing to the comparatively slight action exerted upon it by most chemical reagents. The tar was submitted to repeated fractional distillation, and the portions passing over last were mixed with strong sulphuric acid and violently agitated. After standing in a warm place for some hours, the paraffin floated upon the carbonized residue in the form of a pale-colored oil, which, after cooling, solidified, and was pressed between folds of bibulous paper. By frequent crystallization from boiling ether, it was obtained as a brilliantly white body, highly plastic and somewhat unctuous. For many years it was regarded as simply a chemical curiosity. It is now annually made, as will presently be shown, by thousands of tons.

Paraffin is a pure hydrocarbon, having no oxygen what-

ever, and its analysis has given the following percentage composition : Carbon, 85.16; hydrogen, 14.76.

Paraffin, when pure, is perfectly colorless and translucent; after slightly warming, it becomes highly plastic, and can be molded with the greatest ease. Hence, it differs in some respects essentially from spermaceti, with which it has often been erroneously compared, as well as from stearic acid and other bodies used for the manufacture of candles.

From this plasticity, in warm rooms paraffin candles (if not of a very high melting point) are liable to bend; while, on the other hand, those made of sperm or stearic acid, although of a lower melting point, remain erect. Of course, as has been observed, this very much depends upon the fusibility of the substance, and the harder descriptions of paraffin are always selected for candles which have to be subjected to much heat.

Liquid paraffin is very mobile, and can be filtered through paper almost as readily as water itself.

It is scarcely acted upon, even by fuming sulphuric acid, unless at very high temperatures, so that it can be purified by this means from many other organic substances with which it may have been associated, they being immediately charred by contact with sulphuric acid.

When submitted for a length of time to the action of chlorine or bromine, chlorinated or brominated compounds are formed with disengagement of torrents of hydrochloric or hydrobromic acids.

Mr. MacIvor, who has devoted many years to the study of paraffin, says that, after this body is acted upon by chlorine, it first becomes a gummy-looking solid, afterwards a liquid, colorless and transparent; and as the passage of the chlorine is continued, a hard brittle resin is the result.

The substance consists of—

Carbon	29.55
Chlorine	66.92
Hydrogen	3.39
	99.76

This gentleman has also remarked that the paraffin having the highest melting point are those which are most easily acted upon by the gas.

Iodine dissolves in paraffin, imparting to it a beautiful violet color, which becomes brown as the paraffin solidifies; but the action of this element upon the hydrocarbon is very feeble, no apparent decomposition taking place after prolonged heating for many hours.

By the action of strong nitric or sulphuric acids, M. Campion discovered a new body, which he calls paraffinic

acid, and describes it as a bright, transparent liquid, of a very inflammable nature.

Strong nitric acid yields a series of interesting compounds, lately studied by Schorlemmer and others.

Mr. Fordred informed me some years ago, that when paraffin is acted upon by sulphuric acid to which a few crystals of permanganate of potash have been previously added, the action is so violent that light and heat are involved, and even at times accompanied by explosion. The best way of trying the experiment is to heat up the acid and permanganate in a tube, and drop a small piece of paraffin in the warm liquid. When they are all three placed together in the tube and heated up, the action is not nearly so violent. Success does not always attend the experiment, but it can be tried. The decomposition convinces us that the word paraffin (little affinity) is slightly a misnomer.

Paraffin is insoluble in water, very sparingly soluble in alcohol, even when boiling, more so in ether, exceedingly in naphtha, sulphide of carbon, and aniline.

When heated with sulphur at a moderately high temperature, it is decomposed, carbon separates, and abundance of sulphureted hydrogen is evolved. This fact may be of interest to chemists, as affording a ready source of this indispensable reagent in the laboratory. The two substances, the paraffin being in large excess, are heated together in a flask, when a steady and copious flow of the gas is obtained, and the characteristic action of the gas upon lead salts will be seen by the experiment.

With regard to the beautiful translucency of paraffin, which, in spite of certain drawbacks, has made this body such an unusual favorite as a means of light, Mr. MacIvor informs me that, if, when melted, it is cooled very gradually and subjected to a slight and steady pressure, it becomes actually transparent, like ice, but that a blow, or even a scratch, will alter its molecular structure, and cause it to reassume its normal appearance. As this change is also produced upon remelting it, however cautiously, that triumph of manufacture in this department of industry, namely, making a transparent candle, is yet in the distance.

Mr. Gellatly has shown that the specific gravity rises with the melting point of paraffin. Thus paraffin melting at about 60° Fahr. has only a specific gravity of 0.823 ; at 128° Fahr., which may be considered a very good average (rather high, perhaps), it has a specific gravity of 0.911 ; and a specimen of an extraordinarily high melting point

(176° Fahr.) was as high as 0.940, more than 10 per cent above that at 90° Fahr.

Paraffin is obtained in large quantities by distillation from oil shales.

NEW LECTURE EXPERIMENTS.

Oxidizing Power of Charcoal.—Freshly prepared leucaniline dissolves in alcohol, and forms a perfectly colorless liquid, which may be kept for a long time without change. If this solution is boiled for a few moments with a small quantity of animal charcoal, it becomes of a deep carmine red, due to the action of the oxygen condensed in the pores of the charcoal.

Oxidation Shown by Change of Color in Compounds on Contact with Air.—If a tolerably concentrated alcoholic solution of naphthalene red is boiled for a few minutes with zinc dust, a colorless solution is obtained; and if the flask is corked while full of the vapor of the alcohol, the liquid remains colorless, and the zinc settles to the bottom. If the flask is then shaken so as to wet the sides, and the cork withdrawn, the inner walls are instantly colored deep red. It is only necessary to boil again, in order to repeat the experiment.

Liquid Phosphoreted Hydrogen.—A thick-walled U tube, about one-seventh of an inch in diameter, and provided with a stopcock on each arm, is surrounded by a freezing mixture (16° to 20°), and receives the phosphoreted hydrogen prepared from 7 to 10 drachms of freshly made calcium phosphide. A wide glass tube in the cork of the generating flask, dipping beneath the surface of the water (at about 60°), serves for the introduction of the phosphide. While the liquid is being collected, spontaneously inflammable phosphoreted hydrogen escapes; if this is displaced by a stream of carbonic acid, the bright flame is replaced by a scarcely luminous green flame, of so low a temperature that a taper can not be lighted at it. This flame is caused by the liquid phosphoreted hydrogen in the stream of carbonic acid coming in contact with the air. The carbonic acid may be replaced by a stream of some combustible gas, for example, hydrogen, and a luminous flame again obtained.

Point of Maximum Density of Water.—The apparatus consists of a tall cylinder and a pear-shaped glass float, which is so weighted (with mercury or otherwise) that when immersed in distilled water at 392° Fahr., it neither sinks nor floats. On cooling or heating the water in the cylinder, the float rises to the top or falls to the bottom.

Sodium Press.—The sodium is placed in a metal cylin-

der, at the lower end of which is a fine opening, and forced through by a screw. If it be received in mercury instead of rock oil, a pure amalgam may be readily formed.

Leidenfrost's Experiment Reversed, to Explain the Action of the Alkali Metals on Water.—When potassium is thrown in water, the hydrate formed by the reaction swims about on the water for a few seconds, in the form of a red-hot globule, and then disappears with a sudden explosion. The manner in which this effect is produced may be illustrated by the following experiment: An ellipsoid of pure silver (weighing about 150 grains) is provided with an ear to which a stout copper wire is fastened. If it be heated to redness and dipped into water in a large beaker, it remains passive for five or six seconds, and then a violent explosion suddenly takes place, scattering the water, and usually shattering the beaker.—*A. W. Hofmann.—Deut. Chem. Ges. Ber.* (32)

LIQUID CARBONIC ACID.

CAILLETEL has, by use of an apparatus very similar in principle and construction to that devised by Professor Andrews, of Belfast, succeeded in liquefying carbonic acid, under conditions which enable him to test many of its properties while still in the liquid state. His apparatus consists of a hydrostatic press, by which mercury can be forced, under a pressure of 900 atmospheres, if necessary, into a cylindrical glass reservoir, terminating in a narrower thick tube. Liquid carbonic acid he finds to be colorless, mobile, and a non-conductor of electricity. It is not decomposed by a powerful induction spark, but the spark has, in the liquid, a very white, dazzling appearance. Salt, sulphate of soda, chloride of calcium, sulphur, phosphorus, stearin, and paraffin are quite insoluble in liquid carbonic acid. Iodine is slightly soluble. Liquid carbonic acid is but slightly soluble in water; petroleum, however, dissolves five or six times its bulk. Bisulphide of carbon dissolves sparingly. Ether mixes with it, in all proportions, with great readiness. Liquid fats dissolve in it, but not solid fats. Sodium does not reduce it.

DETERMINATION OF ALCOHOL in water in wines and sugar solutions.—Salleron.—The author shows that in mixtures of water and alcohol the weight of the drops diminishes as the alcoholic richness increases, and that for each degree the differences are variable, and that these differences are very considerable in liquids which contain much water and little alcohol, and that a table of the weight of drops which he has constructed makes it possible to determine alcohol in weak liquors with much precision.

RAPID ESTIMATION OF PHOSPHORIC ACID, MAGNESIA, AND LIME.

I ATTACK in the cold, says M. G. Ville, 30.86 grains of phosphate with 3 cubic inches of hydrochloric acid or weak nitric acid, and filter it. I take 0.3 cubic inch of this solution, add at first some citric acid, then ammonia in excess, and lastly precipitate by a solution of chloride of magnesium, the liquid being maintained ammoniacal.

The phosphoric acid deposits in the form of ammonio-magnesian phosphate. By means of the exhausting filter I separate it from the supernatant liquid, wash it with ammoniacal water, exhaust again, and finally dissolve the precipitate by means of some drops of nitric acid, and estimate volumetrically by means of acetate of uranium, according to M. Leconte's process, to which I have made several useful additions.

Thanks to my new apparatus, the union of the two methods is complete, and the quickness of the process is such that, in less than two hours, ten estimations, at the least, can be made. The estimation of phosphoric acid becomes as easy as that of nitrogen by soda-lime, while it is more general and not less accurate.

Suppose we have to analyze superphosphates of lime of commerce. The necessity of distinguishing phosphoric acid which is in the soluble state from that which is in the insoluble state requires two parallel attacks, one with dis-

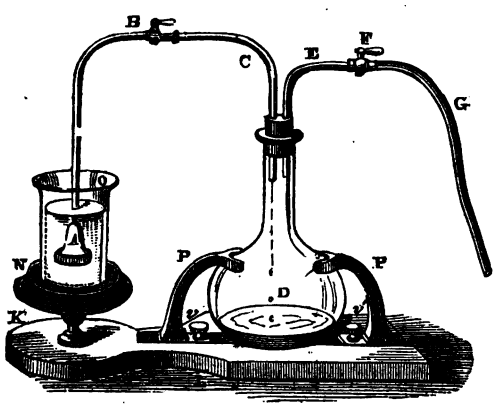


FIG. I.

tilled water and the other with weak nitric acid. The operation is always the same. We work on each liquid

separately, as I have just pointed out in the case of natural phosphates.

I will now describe the apparatus that has so much expedited the work. A glance at the drawing is sufficient to understand their arrangement and mode of action (Fig. 1). An exhaustion is formed, equal to a very few inches of mercury, in the globe, D, by the help of a small hand-pump. The base of the cone, A, covered with one or two discs of blotting-paper, held in place by a ring fitting tightly by friction, works as a true filter, which acts under pressure.

I have adopted two forms of apparatus, one of platinum and the other of glass (Fig. 2). The fragility of the latter is obviated by means of the consolidation arm, M, which firmly fixes the exhausting tube.

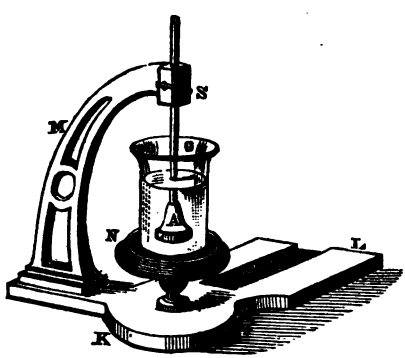


FIG. 2.

The facility which this method gives of multiplying estimations has led me to define, experimentally, all the conditions which could affect the precipitation of the ammonio-magnesian phosphate. Among other results, I have discovered a means of rendering the precipitation almost instantaneous. To effect this, it is necessary to operate on a moderate quantity of phosphate, and to employ an excess of chloride of magnesium. With a small quantity of chloride the precipitation is slow, with more it is quicker, with an excess it is immediate. After waiting a quarter of an hour, we may proceed with the estimation of phosphoric acid, only the filtration takes a little longer; after an hour the result is perfect.

An excess of citrate of ammonia holds in solution very appreciable quantities of ammonio-magnesium phosphate; the loss, however, which results from it is very slight.

Citrate of lime dissolves nearly three times more ammonio-magnesian phosphate than citrate of ammonia. The intervention of 1 grain of lime has sufficed, in fact, to raise the loss of phosphoric acid from 0.033 to 0.066 of a grain; but I have ascertained that an excess of chloride of mag-

nesium, so efficacious in hastening the precipitation of the ammonio-magnesian phosphate, completely neutralizes the solvent action of the citrates of lime and ammonia, and confers on the results both accuracy and concordance.

I have studied the precipitation of phosphoric acid in the presence of lime and aluminum, separately at first, then associated with lime; and I have arrived at the conclusion that, by keeping the quantities of citric acid, of chloride of magnesium, and of ammonia, and of the total volume of the liquid, between certain limits which I point out, the process is of irreproachable accuracy.

Whether we are working with natural phosphates or with commercial superphosphates; whether the product contains sulphuric acid or is free from it; whether the proportions of alumina, oxide of iron, and lime are great or small; the indications of the process are always exact and concordant.

The method possesses the two characteristics of accuracy and swiftness, and a degree of generality which renders it applicable in every case which may interest physiology, industry, and agriculture. (2)

ALCOHOL INTO NITRIC ETHERS.

THIS process, recently reported by M. Champion, allows of operation at the ordinary temperature and upon considerable quantities of alcohol. It is founded on the reciprocal action of a nitrosulphuric mixture and of sulphuric combinations of the alcohols; and as this action is progressive, but a small quantity of heat is disengaged. It is otherwise necessary to cause the concentration of nitric acid to vary. Thus, for example, for the alcohols derived from the fatty series, butylic, amylic, etc., ordinary nitric acid with an excess of sulphuric acid should be employed: in other circumstances, fuming nitric acid at 118.4° Fahr. The sulphuric combinations of the alcohols are obtained by 2 of acid to 1 of alcohol, care being taken to prevent elevation of temperature and the mixture being left to itself for several hours.

This process is possessed of particular interest from its application to the industrial production of nitroglycerine. To glycerine at 30° B., ordinary sulphuric acid is added, care being taken to keep the heat below 122° Fahr. After cooling, the liquid is turned into a light excess of nitrosulphuric acid. Two pounds or so of this mixture can be almost immediately used, without requiring cooling. Although the temperature rises, it in no case gives place, if the operation be properly conducted, to the violent reaction which results from the action of glycerine on the acids,

an effect manifesting itself by a sudden increase of temperature and sometimes by explosion. After a time, which varies with the proportions employed, the oily drops appear. If the operation be performed on some few ounces, the temperature remains constant during several hours. The action continues for twenty hours.

NEW COMPOUND FROM URINE.

THE substance in question, $C_8H_8N_2O$, has a strong resemblance to hippuric acid. It forms white columns of several milimeters in length. Freely soluble in boiling water; sparingly in cold water and spirit of wine; insoluble in absolute alcohol and ether. If heated to 250° Fahr. the crystals experience no change. If more strongly heated, they decrepitate, evolve dense white vapors of a peculiar odor, fuse, and finally burn with the odor of horn. It is neutral to test paper, does not combine with bases, but forms with acids salts which do not readily crystallize, and deliquesce on exposure to the air.—*F. Baumstark.*

PREPARATION OF TIN CRYSTALS.

THE outside of a platinum basin or crucible is covered, with the exception of a small part of the bottom, with wax or paraffin. This basin is then placed upon an amalgamated rod of zinc in a large porcelain basin or beaker. The porcelain basin contains water, with about one-twentieth part of hydrochloric acid; the platinum basin contains a dilute and not very acid solution of stannous chloride. The two liquids must just cover the edge of the platinum basin. After two or three days beautiful crystals are formed in the platinum basin. These may be removed, washed with water, and dried. They must be kept from the air. (32)

ACTION OF PERMANGANIC ACID.

R. BOETTGER states that a mixture of equal weights of dry pulverized potassium permanganate and concentrated sulphuric acid acts so powerfully as an oxidizing agent, that by its mere contact with many substances, especially with essential oils, a violent expolsion is produced, and in other cases the substances are immediately set on fire. Cotton-wool is thus inflamed: but gun-cotton and gunpowder are not. A jet of coal-gas when directed on a few grammes of the mixture is instantly kindled.

MINERAL oil may be detected by its property of imparting a fluorescence to animal or vegetable oils, and by its aromatic odor on burning. The presence of resin may be ascertained by its giving a deeper color with nitric acid than that given by the pure oil.

IRON IN NICKEL SALTS.

TRACES of iron which can scarcely be recognized by the ordinary tests, may, says R. Boettger, be easily detected by faintly acidifying the solution, adding a couple of drops potassium sulphocyanate, and shaking up the liquid with a few cubic centimeters of ether. If the ethereal layer shows a rosy tint after standing for a few minutes, iron is present. If it is wished to remove the iron, the aqueous solution of the salt is boiled for ten minutes with a few grams of nickel carbonate, or, instead of the latter, with a few drops of solution of sodium carbonate; but in this case the liquid must be briskly boiled. The nickel carbonate precipitates every trace of iron at boiling heat as hydrated oxide.

PHOSPHORESCENCE OF PHOSPHORUS.

THE theory of Berzelius, that the phosphorescence of phosphorus is due to the vaporization of the metalloid has been confuted by the experiments of Schrotter, but it has not entirely lost credit. Joubert confirms Schrotter's results. The phosphorescence does not take place in a vacuum, or in the absence of oxygen. It is well known that it is not apparent in oxygen gas at the ordinary temperature and pressure, but that it is necessary to raise the temperature or diminish the pressure in order to produce the phosphorescence. The author believes that there is also an inferior limit below which diminution of pressure causes the phosphorescence to disappear.

The property of phosphorus of giving rise to luminosity with a very small pressure of oxygen has enabled the author to ascertain that mercuric and silver oxides are appreciably decomposed at 100°. The temperatures at which sulphur and arsenic give a phosphorescent cloud are, for the first, about 100°, at the ordinary temperature, and a little higher for the second. Oxygen is necessary for the phenomenon, and there is a superior and inferior limit, as with phosphorus.

PHOSPHORUS A REDUCING AGENT.

R. BOETTGER states that phosphorus, although a metalloid, and a perfect non-conductor of electricity, nevertheless exerts on certain metallic solutions a reducing power comparable with that of good conductors like zinc and iron. A perfectly clean piece of phosphorus precipitates gold, copper, and palladium from their solutions in the metallic state; silver is phosphide. Platinum, uranium, nickel, iron, zinc, cadmium, and cobalt salts are not decomposed by phosphorus at ordinary temperatures.

PREPARATION OF PHOSPHOROUS CRYSTALS.

ACCORDING to W. Douglas Herman, phosphorus may be obtained in crystals in the following manner: A piece of phosphorus is placed in a glass tube, the tube drawn out, the air is exhausted from it by means of a Sprengel pump, and the tube is then sealed and placed in the dark. Within an hour, or sometimes even sooner after the sealing of the tube, a number of shining points can be detected on the sides of the tube, and in two or three days crystals are clearly visible; in a month or six weeks they attain a diameter of 3—5 millimeters. The crystals are colorless and transparent while kept in the dark, but become yellow and lose their transparency when exposed to light.

The crystals have been measured by Maskelyne, who has found in them each of the seven fundamental forms existing in the cubic system.

ACTION OF EARTH AND OTHER SUBSTANCES ON ORGANIC MATTER.

AT a recent meeting of the Chemical Society, a paper on the action of earth on organic nitrogen, by E. C. Stanford, was read, in which the author gave details of his experiments on mixtures of earth and decomposing animal matter. From these it appears that the earth is but an indifferent dryer, the mixture continuously losing nitrogen, which is evolved as ammonia principally; the earth also does not act as an oxidizer, and no nitrification takes place. Dr. Frankland stated that when decomposition was in the direction of putrefaction, ammonia was always produced from the nitrogenous matter, but much nitrogen also escapes in the elemental form. The action of charcoal is very different; seaweed charcoal mixed with excrementitious matters and allowed to dry is found to retain almost the whole of the nitrogen. These facts are of interest to sewage economists and the advocates of the dry earth system.

NEW ALKALOID FROM MORPHIA.

A NEW substance has been prepared, by G. Nadler, by the action of an ammoniacal solution of cupric oxide on morphia. Its chloride is of a brilliant white color, and is easily soluble in hot water, in which the ammonia throws down an amorphous precipitate, that remains unchanged in the air in the moist state. With concentrated sulphuric acid, it becomes of an intensely green color. From the potash solution, when boiled, the alkaloid separates in scales having the lustre of silver. It is, moreover, distinguished from morphia by the trifling solubility of its sulphate; from apomorphia by its stability in moist air.

EFFECTS OF FRICTION IN LIQUIDS.

IT has long been known to chemists, says Mr. C. Tomlinson, that certain saline solutions, which show no disposition to deposit crystals, may be started into crystalline action by rubbing the inside of the vessel below the level of the solution with a glass rod. This effect is produced although every part of the arrangement be chemically clean; and it has not, so far as I know, been explained. It is the same with a gaseous or vaporous solution. Soda-water, in a chemically clean test-glass, in which not a bubble of gas is visible, will display a line of bubbles along the path described with friction by a clean glass, metal, or other rod, against the inside of the glass below the level of the liquid. So also, if a glass rod be rubbed against the side of a vessel containing a liquid (such as spirits of wine, or a saline solution, such as one of common salt) at or near the boiling-point after the source of heat has been removed, bubbles of vapor may be liberated so abundantly that the liquid may be made not only to boil, but to boil over.

A gentle rubbing sometimes fails to convert a friction-line into a bubble line, whereas harder rubbing and a quicker motion produce the effect. And in general hard bodies are more efficacious in producing the result than soft ones. It is not necessary that the friction produce an actual scratching of the surface; nor does the track of a bubble line remain more sensitive than other parts in liberating gas after the first display is over. The more highly supersaturated or superheated the solution, the more sensitive the surface appears to be, and the smaller the amount of friction required. Beer gently warmed produces foam by rubbing the side of the vessel. Or if, instead of rubbing the side of the vessel, two solids, such as copper and steel, be introduced into the liquid and rubbed against each other, bubbles are produced.

Some of my scientific friends to whom I have showed these effects, endeavor to explain them by supposing that the friction produces heat, or electricity, or some molecular change on the surface of the vessel.

Old Mariotte was interested in the same phenomenon. He says, "Each drop of rain, in falling from the height of the cloud, drags with it two or three times as much air as its own size, as may be shown by letting a little ball of lead fall into a bucket of water; for as soon as it touches the bottom two or three bubbles of air rise, each as large as itself, which can only proceed from air which follows it to the bottom of the vessel." He then refers to the *trompe*, in which air is dragged down by the water.

The more rational explanation is that the shot, in plunging into the water, displaces a quantity of that fluid in the form of a well or cylindrical shaft, to which the shot forms the lower boundary, and into which air, as the more mobile body, rushes before the water has time to close over it; and as the shot is still pursuing its journey, it makes a path which the cylinder of air continues to follow until both are arrested at the bottom of the vessel, where they are disposed of according to their respective densities and that of the surrounding medium.

Now to apply this to the liberation of gas from soda-water, etc., by the friction of a hard body against the side of the vessel. The glass rod or the steel knitting-needle, on being pressed against the side of the glass, displaces a certain small quantity of the liquid, and on moving the solid, with friction against the side, successive quantities of liquid are thus displaced. A certain time, however short, must elapse before the water can fairly close in upon the moving points of the line thus traced; but however quick the water may be in filling up the void, the gas is quicker, and hence a friction line becomes a line of bubbles.

The same explanation applies to other gaseous solutions, to solutions of vapor, such as spirits of wine at or near its boiling point, and also to certain saline solutions. The gas, or the vapor, or the salt, fills up the spaces in the friction line more quickly than the liquid part of the solution can do; and thus we have a line of gas or of vapor-bubbles, or a line of minute crystals. (46)

VANILLA FROM PINE TREES.

THERE has recently been submitted to the French Academy some small crystals which are the pure aromatic principle of vanilla. These, it is remarkable to note, were extracted from conifers. The cambrium of the latter contains a crystallized glucoside, coniferine, which MM. Tiemann and Haarmann consider represented by the formula $C^{16}H^{88}O^{18}+2H^2O$. Submitted to the action of emulsion, the coniferine separates into glucose and a component crystallizing in fine prisms which melt at 163.4° Fahr. The latter material is readily soluble in ether, less soluble in alcohol, and insoluble, or nearly so, in water. It contains C^{10} H^{16} O^3. Under the influence of oxidizing agents, the product of the fermentation undergoes a remarkable change. In warming it with a mixture of potassic bichromate and sulphuric acid, it disengages first ethylic aldehyde, and then an acid substance soluble in water, which may be separated by agitating with ether. By evaporating the latter, star-shaped crystals are obtained which

melt at 177.8° Fahr., and which are identical with the aromatic principle of vanilla. The formula is C^8 H^8 O^3, which corresponds exactly with that attributed to the aromatic extract of vanilla.

GLYCYRRHIZIN, OR LICORICE JUICE.

P. GRIESSMAYER says: "It has been suspected that sugar, extracted from licorice root, has been used for the purpose of adulterating beer, and yet the opinion of chemists has been that such sugar is not fermentable. Glycyrrhizin is a glycoside, which, on being boiled with acids, decomposes into glycyrretin and sugar. Even after boiling it with water, sugar may be detected by Fehling's test. The sugar obtained in this manner was treated with yeast, and after three days the fermentation was complete, and alcohol was found in large quantity by means of the well-known reaction converting it into iodoform. During the latter stage of the fermentation a peculiarly disagreeable putrid odor was perceived, and the substance emitting it passed over into the distillate; the disagreeable taste of some German beers is doubtless owing to this body. (36)

SUGAR FROM CAOUTCHOUC.

CAOUTCHOUC from Madasgascar yields a saccharine substance, which A. Girard has named "matezite," from the native word for caoutchouc. Matezite is white, very soluble in water, less soluble in alcohol, from which it crystallizes in tufts. It melts at 181° to a vitreous mass, which does not crystallize on cooling, and may be sublimed at 200°–210° without decomposition. It deposits in drops. Its formula is $C_{10}H_{20}O_9$; and on treatment with hydriodic acid, it undergoes a decomposition analogous to the others, forming a sugar called by the author *matezodambose.*

GAIN IN WEIGHT BY COMBUSTION.

AT a recent lecture before the Franklin Institute, Mr. Theodore D. Rand showed a simple and satisfactory experiment to demonstrate the increase in weight of burning bodies, caused by their absorption of oxygen. About an ounce of fine turnings of zinc, produced in the spinning of that metal, were loosely wrapped with iron wire and suspended from the arm of a balance. The pan on the other arm having been weighed to counterbalance the zinc, the latter was ignited with a match. At first the combustion was rapid, and much oxide escaped in fumes, causing the zinc end of the balance to rise. Soon, however, the combustion became a mere glow, the absorption of oxygen taking place without fumes. In a minute the beam

began to descend, and soon very decidedly outweighed the counterbalance.

The only precaution necessary is to have the zinc moderately but not too compact. If too lose, it burns too rapidly; if too compact, it will not burn.

NATURAL GAS FOR PUDDLING.

A NOVEL feature in iron-working has been introduced recently by Messrs. Rogers & Bruchfield, of the Siberian Iron Works, Pittsburg, which consists in the application of gas from a gas-well as fuel. Their mill is situated at Leechburg, Armstrong County, and is devoted to the manufacture of sheet-iron. The well is situated on the opposite side of the Kiskiminetas River from the works, and is 1,200 feet deep. The gas is let from the well through steam-pipes into a horizontal cylinder, with safety-valve near by, and thence across the river to the mill. Here it is fed under the boilers through a horizontal pipe, running longitudinally their entire length, pierced with small holes. A very perfect combustion is secured in this way. It is fed in the puddling and heating furnaces in like manner, through a pipe in the rear of the fire-bridge, but here the combustion is not so perfect, and considerable black smoke is seen issuing from the stacks. An ample supply of gas is furnished by the well, and at a very regular pressure, which has not been measured, but is thought to be over 30 lbs. The volume of gas used is easily controlled by cocks, and can be adjusted for various purposes with the utmost nicety. Mr. Rogers estimates that the saving to them in fuel amounts to $700 per week, and states that they obtain 33⅓ per cent more yield from the metal than they did when using coal—at the same time producing an article of very superior quality, on account of the purity of the gas. The firm is now manufacturing an article of tin-plate, which they claim to be equal, if not superior, to any manufactured abroad, which they could not do when using coal. The well was bored for oil originally, and had been in existence some four years.

Professor Wurtz shows that there are three belts of gas-wells running across New-York State. In view of the successful application of natural gas to puddling in Pennsylvania, he suggests a trial boring here. "Think," he says, "what a noble thing may be before us: should we find ourselves able to tap and draw from stores of gas pent up under the Catskill range, conduct this gas to the brink of tide-water along the Hudson, and operate therewith upon the pure limonites of Putnam, Dutchess and

Columbia, and the magnetites of Orange and Rockland, Champlain and the Adirondacks. 'Making two blades of grass grow where one grew before' would be a feeble figure of speech to apply."

NEW MAGNETO-MECHANICAL SEPARATOR.

A NEW form of magnetic separator, for the removal of fine particles of iron that become mixed with turnings and filings of copper and brass from workshops, has recently been devised by M. Varin, of Paris.

Two superposed hollow cylinders turn in the same direction, and upon them the material to be separated is scattered through a hopper. The surface of the cylinders consists in bands of soft iron which are kept in a magnetic state. The particles of iron are attracted to these cylinders, and at a certain period of revolution are brushed therefrom into a receptacle, while the scraps of other metal fall to the bottom of the apparatus. The machine is said to be capable of separating 1,100 pounds of material per hour. It has also recently been employed by M. Mangon for detecting titanic iron in arable earth, with remarkable precision, the iron, in such small quantities as 15 or even 7 grains in 22 pounds of earth, having been readily separated.

PALLADIUM foil, says R. Boettger, when charged with hydrogen and heated so that water hisses strongly when dropped thereon, does not part with all its hydrogen, but retains the power of reducing a dilute ($\frac{1}{10}$ per cent) solution of ferricyanide of potassium on immersion therein for ten minutes; the hydrogen is only expelled by heating for a long time to redness. [Query, is it not wholly expelled at a lower temperature in a Sprengel vacuum?]

Nickel and also thin electrolytic cobalt plates and pure tin, can also take up hydrogen; but cadmium, zinc, aluminium, copper, irridium, lead, silver, mercury, bismuth, gold, uranium, osmium, platinum, chromium, and silicum, are wholly indifferent.

If palladium foil coated with palladium black (electrolytically deposited spongy metal thrown down from the chloride) be fully charged with hydrogen wiped dry, and quickly wrapped in gun-cotton, the latter explodes in a few seconds, and the foil appears to burn with along blue flame for 5—10 seconds; such charged foil immersed in absolute ether evolves part but not all of its hydrogen; the gas burns with a luminous flame [query, from presence of ether vapor?], whence the author infers that the ether has been converted into ethylene.

GASES AND VAPOR CONDENSED BY CHARCOAL.

WHEN wood charcoal, saturated with dry chlorine, is placed in the longer branch of Faraday's siphon gas-condensing tube, and the heat of boiling water is applied to it, the shorter branch being placed in a freezing mixture, a portion of the gas is volatilized. Pressure being thus developed, liquefied chlorine soon appears in the tube. The experiment is well adapted for a lecture demonstration. The author has liquefied in this manner ammonia, sulphur dioxide, hydrosulphuric acid, hydrobromic acid, ethyl chloride, and cyanogen.

Wood charcoal retains so firmly the vapors of the volatile liquids, bromine, hydrocyanic acid, carbon sulphide, ether and alcohol, that, upon repeating with them the experiment just described, no liquid is obtained.

Pouillet observed a slight evolution of heat when water, oils, ethyl acetate, and alcohol were absorbed by mineral powders, and still more marked effects with organic powders. The author finds that, with charcoal, still more heat than in the above case is given out, when it absorbs liquids upon which it has, apparently, no chemical action. Thus with 5–10 grains of charcoal, and 40–80 grains of bromine, the temperature was raised 30° C. If the charcoal had been previously heated to expel gas, and then cooled *in vacuo*, the absorption of bromine being also conducted *in vacuo*, no doubt the rise of temperature would have been still greater.

NEW EXPERIMENTS IN CONVECTION.

THE phenomenon of convection of heat in a liquid, consisting in that the superior portion of the mass is always at a more elevated temperature than the lower part, can be clearly illustrated by the following novel experiments:

Two glass tanks are placed before a white surface; one is filled with cold and the other with boiling water. A solution of starch is freshly prepared in a large test-tube, and, by the addition of an aqueous solution of iodine, colored a deep blue. The liquid is then warmed until this color just disappears, care of course being taken not to add an excess of iodine, which would prevent this action; and the tube is then plunged into the cold water. The blue color, brought back by the cooling, will appear first in the lower portion of the tube, and will gradually extend upward, thus proving that it is the lower portion of a warmed liquid which first becomes sufficiently cooled to cause a return of the tinge.

In the other tank, containing boiling water, a similar test-tube, containing a blue liquid obtained by the addi-

tion in excess of caustic potash to a solution of sulphate of copper and tartaric acid, to which a little grape-sugar is added, is placed. The formation of yellow oxide of copper begins at the surface of the liquid and descends gradually to the lower portions, showing that it is the upper part which first attains the temperature necessary to cause the reaction which precipitates the oxide of copper.

CARBONIC ACID AS A MOTOR.

THE possibility of employing carbonic acid as a motor—the successor of steam, as it is termed by the author—is foreshadowed by a paper by Dr. H. Beins, published in the English *Chemical News*. The writer considers that he has discovered a very cheap way of producing carbonic acid in a liquid state, and consequently at high tension. When natrium bicarbonate, or the corresponding salt of kalium, in a dry, pulverized state, or in a watery solution, is heated in a closed space, a part of the carbonic acid is given off and condensed in a non-heated portion of that space, so that, at a temperature of from 636° to 843° Fahr., liquid carbonic acid, says Dr. Beins, can be distilled out of those salts, with a tension of from 50 to 60 atmospheres. This liquid carbonic acid, or "carboleum," as it is called, it is proposed to use to develop gas with which engines are to be driven. The paper on the subject contains a dissertation on the advantages of the plan, but gives so few details regarding its practical application, or with reference to the manufacture of the carboleum or liquid carbonic acid, that the gist of the matter is summed up in the above lines.

MUSCARINE.

THIS is the poisonous principle extracted from a mushroom of the genus *agaricus*. According to Dr. Prevost, of Geneva, when it is administered in a very weak dose it acts with force upon the pancreatic and biliary, while lessening the urinary, secretions. It is known that the sulphate of atropine produces exactly the contrary effects, so that these two poisonous substances are therefore antidotes to each other.

HOT FILTERING.—The apparatus consists of a tube of soft sheet-lead, which can be wound around the funnel containing the filter in the form of a spiral. One end of the tube passes through a cork in the neck of the flask, in which water, or other liquid of higher boiling point, is boiled ; the other end dips into a receiver into which the condensed liquid flows.

EXPLOSION OF GUNPOWDER.

MESSRS. ABEL and NOBEL communicate to the French Academy of Sciences the results of their observations on the explosion of gunpowder. They find that when the volume of the powder equals that of the chamber wherein it is exploded, the tension of the confined gases equals 41.7 tons, or 6,400 atmospheres, or over 93,000 lbs. to the square inch. They give also the law of the variation of this pressure with the expansion of the gas. The permanent gases resulting from the explosion have a volume of only about 280 times the volume of the original solid powder. The decomposition of one gramme of powder developed about 75 gramme units of heat; the temperature at the moment of explosion is about 2,200° C.

COMBUSTION OF POWDER.

As the result of their extended series of experiments, details of which we have from time to time published, Messrs. Noble and Abel conclude that the explosion of gunpowder determines a temperature of 4,664° Fahr., comparable to that of the fusion of platinum. The products of the explosion consist in 57 per cent of solid matters and 43 per cent of permanent gases, the latter consisting of carbonic acid, nitrogen, carbonic oxide, and sulphureted hydrogen. Small grained powders give less gas than those of large grains; but generally the variations are so great that it is impossible to express the reaction by any chemical formula. The solid matters are mainly carbonate, sulphate, and hyposulphite of potash.

THE COLORING MATTER OF WINE.

E. DUCLAUX states that the coloring matter of wine is a substance resembling gooseberry-jelly, and dissolving in water or alcohol with a very faint grayish tinge, which, on adding a trace of an acid, assumes a bright red color. When exposed to the air, it takes up oxygen, especially when heated, the compound becoming darker and more and more insoluble, and remaining on evaporation as an opaque coating, which dries up to scales. It is still soluble in alcohol, with a purple color; on adding water, the solution remains clear at first, and a precipitate is but slowly formed, quickly, however, when a trace of an acid is added. The dried precipitate forms a hard amorphous mass, having a metallic reflection. On heating the powder with a little concentrated potash, it first turns green, then red, and after a few moments it dissolves. Acids precipitate from the alkaline solution a gelatinous mass, which is soluble in alcohol, and reprecipitated by acids.

Wine is often colored by the flowers of the mallow, by

Phytolacco decandra, and cochineal. The coloring matter of the mallow differs from that of wine by becoming less and less soluble, by the absorption of oxygen, while that of Phytolacca is decolorized by nascent hydrogen, which acts very slowly on the coloring matter of wine. The presence of cochineal is detected by its absorption spectrum. (4)

EGYPTIAN BLUE.

A REMARKABLE and very beautiful shade of blue is noticeable upon many of the ancient ornaments found in the tombs of Egypt. Analysis some time since proved the color to be formed by a combination of soda, sand, and lime, with certain proportions of copper, from which substances the Egyptians managed to produce three different products: first, a peculiar kind of red, green, and blue glass; second, a brilliant enamel, and lastly, the color to which reference is above made, and which was used for painting. By synthetical experiments, M. Peligot has succeeded in reproducing this peculiar shade of blue, by heating together 73 parts of silica with 16 of oxide of copper, 8 of lime, and 3 of soda. The temperature should not exceed 800° Fahr., as, in such cases, a valueless black product is the result.

ANILINE COLORS ON WATER.

A. OBERMEYER describes some curious phenomena produced when a drop of a solution in commercial aniline of aniline blue, or fuschine, is placed on the surface of water contained in a very wide vessel. A disc is formed, surrounded by several well-defined rings of prismatic colors, and from its margin rays shoot out in straight lines. The explanation is to be sought in the relations between the tensions in the superficial films of liquids pointed out by Van der Mensbrugghe.

FATTY MATTERS IN CAST-IRON.

AN experiment made long ago by Proust revealed the fact that fatty matters can be extracted from cast-iron when the latter is dissolved in certain acids. M. Cloez has recently separated these materials in a pure state, and their analysis reveals the interesting fact that they consist of carburets of hydrogen of the series $C^{2n}H^{2n}$, and present all the terms thereof at least from C^6H^6 (propylene) to $C^{16}H^{16}$. This is a veritable organic synthesis, realized by the aid of substances purely mineral, and is susceptible consequently of important applications. In the SCIENCE RECORD for 1873 will be found an account of the extraction of similar matters from meteoric iron.

THE CRYSTALLIZATION OF GLASS.

AN engineer of a glass-bottle manufactory at Blanzy, France, recently substituted for the crucibles, ordinarily employed in melting the glass, a large cistern furnace

CRYSTALLIZATION OF GLASS.

heated by gas. An accident occurred rendering it necessary to withdraw the fire and, on scraping the glass from the inclined portions, a quantity of magnificent crystalline formations were found, produced during the cooling of the vitreous contents. These masses, a representation of one of which is given herewith, were sent to M. Peligot for examination, and that scientist has pronounced them different from any similar formations yet noticed in glass-furnaces. The crystals are entirely isolated, and are not mixed with transparent glass. They are prisms of from 0.6 to 0.9 inch in length. The explanation given for the phenomenon is that the dentification is due to a separation of the vitreous elements, which give rise to a definite silicate, crystallizing in the midst of the residual mass. This seems to be proved by an analysis of the crystals, in which soda is almost entirely absent, and magnesium present in large proportion. (121)

BEACH MINING IN CALIFORNIA.

ON the coast line of Klamath County, Cal., there is a remarkable deposit of auriferous gravel. For nine miles along the beach an unbroken line of cliffs, towering from one to five hundred feet, serves as a sea escarpment to the mountains behind, and these are immense masses of gravel of varying size and of distinctly marked layers or stratifications. In these "gold bluffs," as they are termed, the precious metal is found in considerable quantities, principally in the tenth strata, which is "black sand" or gravel with iron cement.

After the sand is reached, it is shoveled into little piles, and thence into canvas bags containing about 125 pounds each. These are loaded on mules, each animal carrying two, and thus transported to the "sand corral" in the works. The washing is done in "Long Toms" with copper plates, the latter being first coated with silver, before the quicksilver is applied. Mr. A. W. Chase states that, during the week he visited the mines, $1,600 was retorted from the washings of two machines. He points out that, as the experience of the successive proprietors of this extraordinary gold mine goes to prove, immediately after a heavy cave or slide of the banks, the beaches are richer and the gold coarser, it seems strange that, up to the present time, no artificial means have been resorted to in the way of blasting down the cliffs or undermining them by hydraulic process to increase the yield of gold. The sea, working ceaselessly night and day, is the great natural separator, and man has but to gather the results of its tireless work.

REMARKABLE QUICKSILVER MINES.

THE Elgin mine, Colusa Co., Cal., is as yet undeveloped, but the richness of the prospect is self-evident. Everywhere seams of the richest ore are revealed to view, and ere long it will turn out to be one of the richest mines in that vicinity. The Elgin company opened their mine about six months ago, and have now a force of ten men, together with a retort, from which they run four flasks per week. They are busily engaged in running tunnels, and ere long we will hear of a big strike for the Elgin. This mine is under the superintendence of J. Melbourne. While we were present, they ran off a retort of 34½ per cent ore. The Abbot in richness is undoubted. Ten experienced miners are continually employed in extracting furnace ore, and the work goes on night and day. They are now busily preparing to build a furnace at a cost of $10,000.

The Buckeye is the best developed mine in this region. Seams of the richest cinnabar are plainly visible wherever the eye glances, and from this mine very little waste rock is extracted. The Buckeye runs a force of twenty-eight men steadily, and retorts weekly fifteen flasks of quicksilver. A flask is considered worth $100.

The Empire is a new and rich prospect, struck but a month ago. The value of this mine is in the small amount of labor necessary to work it, it being all clay soil, composed of magnesia, lime, and cinnabar.

The mines in this section of our country excel all we have seen in richness. The very best ores, which will average 30 per cent, are found on the surface of the hills.

A WONDERFUL GAS-WELL.

We can not forget, says the Colusa *Independent*, to make mention of the gas-fire which issues from the mountain in close proximity to the Elgin mine. The side of a hill is all ablaze, and has been so for eight years, when fire was communicated to the gas which emitted, by M. G. L. Eaton, and has been burning steadily ever since. This accrues enormously to the richness of the Elgin, as they can run their furnace with little or no expense. An escape is now taking place of 125 cubic feet, sufficient to run a dozen furnaces.

This portion of our county abounds in quicksilver wealth, and those owning mines will at first have to encounter difficulties, but ere long they will overcome the hardships of developing their mines; and in all experience with regard to mineral wealth, Colusa has the richest.

THE PHILOSOPHY OF WELDING.

IN order to find a true analogy to welding, we need go no further than the vulgar "sticking together" of two pieces of cobbler's wax, pitch, putty, or clay. These are in a viscous or semi-fluid condition, and they cohere by an action similar to the transfusion or intermingling and uniting of two liquids. Iron and platinum pass through a viscous or pasty stage on their way from the solid to the liquid states, and the temperature at which this pasty condition occurs is the welding heat. Other metals are not weldable, because they pass too suddenly from the solid to the liquid condition. Ice, although it fuses slowly, in consequence of the great amount of heat rendered latent in the act of fusion, passes at once from the state of a brittle crystalline solid to that of a perfect liquid. It passes through no intermediate pasty stage, and therefore is not weldable, or does not cohere like iron, etc., at a temperature below its fusing point.

It is usual to cite only iron and platinum, or iron, platinum, and gold, as weldable substances; but this, I think, is not correct. Lead should be included as a weldable metal. The two halves of a newly cut leaden bullet may be made to reunite by pressure, even when quite cold. This is obviously due to the softness or viscosity of this metal.

Outside of the metals there is a multitude of weldable substances. I may take glass as a typical example of these. Its weldability depends upon the viscosity it assumes at a bright red heat, and the glass-maker largely uses this property. When he attaches the handle to a claret jug, or joins the stem of a wine-glass to its cup, he performs a true welding process.

The chief practical difficulty in welding iron arises from the fact that at the welding heat it is liable to oxidation, and the oxide of iron is not viscous like the metallic iron. To remedy this oxidation the workman uses sand, which combines with the oxide and forms a fusible silicate. If he is a good workman he does not depend upon the solidification of this film of silicate, as the adhesion thus obtained would be merely a soldering with brittle glass, and such work would readily separate when subject to vibratory violence. He therefore beats or squeezes the surface together with sufficient force to drive out from between them all the liquid silicate, and thus he secures a true annealing or actual union of pure metallic surfaces.

Cast-iron or steel containing more than two per cent of

carbon can not be welded. Why? I think I may venture to reply to this oft-repeated question by stating that the compound of iron with so much carbon is much more fusible than pure iron, or than steel with less carbon, and that it runs more suddenly or directly from the solid state into that of a liquid, and hence presents no workable range of weldable viscosity.—*W. Mattieu Williams.* (106)

WHITWORTH STEEL.

SOME idea of the solidity of compressed castings of Whitworth metal may be gleaned from the fact that, five minutes after the application of pressure—about twenty tons to the square inch—a column of fluid steel becomes shorter by 12.5 per cent, or 1½ inches to the foot. Sir Joseph Whitworth holds the proposition that for certain purposes a metal must be used having a certain tensile strength and a certain percentage of ductility. Hence the metal cast at the Whitworth works is classified according to its possession of these qualities, and arranged for convenience in four groups, distinguished by colors, red, blue, brown, and yellow, and by numbers, No. 1 of each group representing the most ductile metal, and No. 3 the least so. Of Low Moor wrought-iron, the tensile strength per square inch is 27 tons, and ductility or percentage of elongation, 38. In good cast-iron the same qualities are represented by 10 and 0.75. Various samples of Whitworth steel similarly tested gave from 36 to 72 tons tensile strength, and from 33.3 to 14 per cent elongation. There is shown a singular relation between the tensile strength and ductility of the metal, the one generally increasing as the other decreases, a circumstance which, it is suggested, may possibly deserve investigation.

PHOSPHOROUS STEEL.

M. EUVERTE, director of the Terre Noire foundry in France, communicates to the *Société des Ingénieurs Civils* some important results of his researches, carried on over the past two years, with a view to determine to what point it is possible to introduce phosphorus in steels. Phosphorous metals having been placed in sufficiently large proportion in a Siemens-Martin furnace, and the operation having been terminated with ferro-manganese, with 42 per cent of manganese, or with spiegeleisen, it was found that the metal obtained was of good quality and malleable. It was established that the cast steels can contain a certain proportion of phosphorus without losing their malleability or their valuable qualities of resistance. A steel containing 0.003 of phosphorus and 0.0015 of carbon may be utilized for making an excellent rail.

CARBON IN IRON AND STEEL.

BY A. GREINER.—The iron manufacture furnishes at present two kinds of products identical in chemical composition, and differing only in the mode of working, viz., iron and steel, the latter including those varieties which have been fused and cast into molds, and yield compact homogeneous bars, whereas the irons which have not been fused still retain the portions of the slag and heterogeneously constituted metal existing in the blooms. The first class begins with ordinary iron in its different states, and passing upwards to granular iron, finally reaches the steel iron, or puddled steel, which is frequently so rich in carbon, that it may be tempered, and frequently it is as little malleable as Styrian steel. This puddled steel is a kind of fine wood-charcoal pig-iron, and is so far decarburized, that a simple manipulation in the furnace is sufficient, if necessary, to render it capable of being hammered, and drawn out into very good steel wire. At the head of this kind of products are the cemented irons or steels, which are usually derived from iron strongly carburized by direct contact with charcoal. The second class of products comprises the steels; it runs quite parallel to the former one, and each member thereof has an analogue in the former line of products. It begins with "very soft steel," which may be welded like iron, and does not admit of being tempered, and terminates with "hard steel," corresponding to "cemented iron or steel and Styrian steel." This last member is difficult to weld, but may always be tempered. The following is a summarized table of these two lines of products, with the average percentages of carbon contained in the several members:

Carbon	0 to 0.15 p. c.	0.15 to 0.45 p. c.
Iron group	Ordinary iron	Fine-grain iron
Steel group	Very soft steel	Soft steel
Carbon	0.45 to 0.55 p. c.	0.55 to 1.50 p. c. and more.
Iron group	Steel-like iron or puddled steel	Cemented iron or steel and Styrian steel
Steel group	Half-soft steel	Hard steel.

It must be remembered that the above members shade gradually into each other, in physical properties as well as in chemical composition, so that the distinct line of separation can not be easily drawn. (90)

ETCHING IRON AND STEEL.—Professor Kick.—After numerous experiments the author finds that the best solution for etching iron and steel to show its grain, texture, graphite present, etc., is equal parts of hydrochloric acid and water, to which is added a trace of chloride of antimony.

ABSORPTION OF GASES BY GRAY PIG-IRON.

RECENT experiments by Mr. John Parry add to our previous knowledge of the strange absorbent and occluding power of iron for gases, that it possesses the like power in reference to a number of metallic vapors, among which that of metallic arsenic is remarkable from the circumstance stated by the author, that its vapor, when once absorbed, is not again evolved upon heating the iron.

IRON is not volatile, except at very high temperatures, like gold and platinum. Dr. Elsner, director of the Berlin Porcelain Works, has tried the experiment of subjecting a small piece of iron, in an unglazed crucible, to a long-continued exposure to a temperature of over 3,000 Cent., when he was distinctly enabled to recognize minute needles of crystallized iron on the cover of the crucible, the result of vaporization.

CAST-NICKEL PLATES.

FOR some years back much attention has been drawn to the galvanized plating of metals, especially iron, with nickel, and larger plates of metallic nickel have been much wanted for the anodes of the galvanizing nickel-salt baths. The extraordinary refractory nature of pure metallic nickel has been, till lately, a great hindrance to the casting of large plates. Borchert, however, has lately succeeded in casting nickel plates 18 inches long, 14 inches broad, and $\frac{1}{8}$ thick. The nickel hitherto used, Saxon Würfel-nickel of 98 to 99 per cent strength, is fused in crucibles in a simple brazier's furnace, by a coke fire. The fusion requires continual and laborious attention, the metal not becoming fluid till after at least six hours' firing. As soon as it becomes fluid, it must be cast without delay into the sand-molds, for as soon as the fire drops a little, the nickel is liable to solidify again into a solid mass, in which case a renewed fusion in the same furnace is impossible.—*C. A. Borchert.*

NICKEL IN MISSOURI.

THE nickel mines of Mine La Motte, Missouri, are being very extensively worked at the present time, and the owners, the La Motte Lead Company, have turned almost their entire attention to raising and reducing the nickel ore to regulus, which is being shipped in large quantities. Recently 7,000 lbs. of nickel ore were raised in one day, worth $1 per pound at the mine. The work was done by six miners, $7,000 being dug out for a cost of less than $25.

MANUFACTURE OF POTASSIUM IODIDE.

CUPROUS iodide, which is imported in considerable quantity from Peru, contains from 60 to 70 per cent of iodine, and furnishes a very suitable material for the preparation of pure potassium iodide.

In Langbein's process, this iodide is reduced to a fine powder, and suspended in water to which a few drops of hydrochloric acid have been added. It is then decomposed by a stream of sulphureted hydrogen, and the excess of gas is destroyed by a solution of iodine in iodide of potassium, after the liquid has been decanted from the insoluble copper sulphide.

Potash, or potassium bicarbonate, according to the purity of the product required, is then added in sufficient quantity, and the whole evaporated till crystallization takes place. During the evaporation the suspended sulphur gathers together in balls, and sinks to the bottom.

The iron sulphate formed in the preparation of the sulphureted hydrogen covers the expense of the acid and iron sulphide used, while the copper sulphate obtained by roasting the copper sulphide covers the other expenses. One point to be looked to is to decant the liquid at once from the copper sulphide, as otherwise copper sulphate is formed by oxidation, and the final product rendered impure.

EXPERIMENT WITH POTASSIUM.

TO show the green color of gaseous potassium, it is volatilized in wide horizontal tubes through which hydrogen passes, which becomes spontaneously inflammable, and burns with a brilliant violet flame, while the hot part of the tube becomes filled with green vapor, condensing in the colder parts as a mirror. When the experiment is finished and air gradually admitted, the potassium is first oxidized to the blue quadrant-oxide.

CRYSTALLIZATION OF TIN.

A FINE crystallization of tin is obtained as follows: A platinum capsule is covered with an outer coating of paraffin or wax, leaving the bottom only uncovered. This capsule is set upon a plate of amalgamated zinc in a porcelain capsule. The platinum is then filled completely full of a dilute and not too acid solution of chloride of tin, while the porcelain is filled with water acidulated with one-twentieth of hydrochloric acid, so that its surface comes in contact with the surface of the liquid in the platinum. A feeble electric current is set up, which reduces the salt of tin. The crystals formed after a few days are well developed. They are washed with water and dried quickly.

THALLIUM.

THE optical process of detecting thallium in a mineral is very simple, says Dr. Crookes. A few grains of the ore are crushed to a fine powder in an agate mortar, and a portion taken up on a moistened loop of platinum wire. Upon gradually introducing this into the outer edge of the flame of a Bunsen's gas-burner and examining the light by means of a spectroscope, the characteristic green line will appear as a continuous glow, lasting from a few seconds to half a minute or more, according to the richness of the specimen. By employing an opaque screen in the eyepiece of the spectroscope to protect the eye from the glare of the sodium line, thallium may be detected in half a grain of mineral when it is present only in the proportion of 1 to 500,000. The sensitiveness of this spectrum reaction is so great that no estimate can be arrived at respecting the probable amount of thallium present.

NEW METHOD OF PREPARING ALUMINUM.

THE oxide of aluminum is first prepared by any of the processes now in use, either from kaolin or clay. It is then mixed with wood charcoal, in the proportion of 40 parts charcoal to 100 of alumina, and heated to a red heat. While still hot, the mass is placed in retorts heated to dark redness, and chlorine gas is passed over it from a gasometer. The volatile chloride is condensed in the receiver, and afterwards decomposed by the battery; the chlorine which is set free is returned to the gasometer to be used over repeatedly. Garneri employed a magneto-electric apparatus.

NEW PROPERTY OF METALLIC RHODIUM.

MM. H. ST. CLAIR DEVILLE and DEBRAY state that rhodium, precipitated from its solutions by formic acid or alcohol, decomposes the formic acid with a disengagement of heat, and reduces it to its elements, hydrogen and carbonic acid. This action continues almost indefinitely. When the action of the rhodium on the formic acid becomes weak, it is merely necessary to wash and dry the metal in contact with air in order that the phenomenon be repeated with its primitive intensity, disengaging equal volumes of carbonic acid and hydrogen.

LUTICINE OR PARIS METAL.—MM. Le Mat, Picard, and Bloch give the following proportions for this alloy: Copper 800, nickel 160, tin 20, cobalt 10, iron 5, zinc 5. Total, 1,000.

COMPOUND CUPOLA FURNACE.

SWAIN proposes the use of a cupola furnace, in which an auxiliary reservoir is attached to the bottom of the cupola. The metal as it liquefies, instead of lying, as heretofore, in the hearth of the cupola, below the tuyères, is in this arrangement tapped off and collected by a passage in an auxiliary chamber or hearth. In the former case the metal is tapped off just as impure as it falls through the mass of coke, ore, and sulphurous gases in the charge above. In the latter arrangement, when the damper is opened, a portion of the hot air from the tuyères, having passed across the hearth, finds its way into the reservoir and plays over the extended surface of the bath of metal. In this way much of the excess of carbon is oxidized, and the sulphur, silica, and other impurities are oxidized and carried off as gases up an auxiliary chimney.

The advantages of this arrangement are numerous. This reservoir, which can with ease be applied to any old cupolas, enables a much larger quantity of metal, compared with the size of the cupola, to be stored up and kept warm than can be done with the old style of furnace. This gives an easy method by means of which the capacity of any existing cupola may be readily increased to meet a demand for heavier castings. It is also noticeable that the part of the blast producing heat to keep the charge liquid, is not obliged, as in ordinary cases, to pass through the whole of the fuel. Thus a considerable economy is claimed to be effected; the fuel used being simply that required to effect fusion, the fusion being afterwards kept up apart simply by the hot-blast, and the oxidation taking place in the bath itself.

The advantages that the inventor claims are as follows: (1) the fusion takes place more rapidly, and the weight tapped is much greater than under the old system; (2) the passage of the hot-blast over the surfaces of the liquid metal facilitates the oxidation of all impurities contained in the metal; (3) the liquid metal is heated more strongly, and is better mixed; (4) there is economy of time; (5) large masses can be cast with the same ease as small ones; (6) a considerable economy of fuel is effected; (7) the liquid metal can be retained and kept hot for a considerable time. In fact, the action of the reservoir has all the effect of refining, the silicon, sulphur, and phosphorus being largely carried off in the bath.

The same cupola and reservoir may also be applied for the fusion of pig-iron for puddling. The liquid metal will run then directly from the reservoir to the puddling fur-

nace, and thus save the reheating. This would represent a large economy over the ordinary methods. Another advantage is obtained in the reduction in the expense of repairs to the puddling furnaces, caused by the reduction of the pig-iron on the hearths of those furnaces. Since if the metal is introduced in a liquid condition into the furnaces, the production of iron is doubled in a given time, the expenses of repairs and interest on capital are all halved.

The idea of puddling direct from a cupola is by no means novel, but it has hitherto been practically unsuccessful by reason of a want of refining in the products of cupolas, and by difficulties which are obviated by the use of an auxiliary reservoir, upon the surface of which a refining jet of hot air plays. The same application might, perhaps, be made to the Bessemer apparatus, which requires costly fusing furnaces. (106)

NEW PUDDLING FURNACES.

RILEY AND HENLEY have devised a new form of furnace, made in the shape of a circular revolving pan with slanting sides. The pan is caused to revolve by any suitable means; the most preferable method being to mount the revolving pan on a vertical shaft which is set revolving by bevel gear; the shaft is supported by a footstep and a collar or neck bearing arranged in a cross-shaped bracket, which also at its four legs or arms stays the bottom of the two opposite outer furnace plates, back and front together. The driving gear for this revolving pan has two or more motions worked by frictional clutches, and may also, if desired, be worked by a separate engine, the speed of which is under the direct control of the puddler. The top of the pan is formed with a flange all around, either cast on, or made separately of cast or wrought-iron and fastened on. This flange or hanging lip dips into a circular trough kept constantly supplied with water, thus forming a water lute and keeping the air from entering into the pan at any part of the circumference, the outside of the pan at the same time being exposed to a full current of air, especially while the pan is revolving.

To prevent the rushing in of air into the pan from between the trough and the surrounding brick-work, a flange with a hanging lip is fastened to the brick-work all round the trough, the hanging lip also dipping into this trough and forming a lute joint there. To bring about a better diffusion of heat, the trough may be made to revolve.

The upper edge of the pan may be cast hollow to form a water compartment all around, and this compartment is

connected to a central tube with an internal tube, with swivel tube joints at the bottom of the vertical shaft, and so arranged as to cause a continual circulation of water.

The other portions of this new puddling furnace are built up and stayed by bolts and plates like the ordinary puddling furnaces. only that the plates at the back and front of the revolving bottom are cut short below so as to admit the air freely there. An ordinary puddling furnace can thus be easily converted according to this invention.

The tools used in connection with this furnace are somewhat different from the ordinary appliances. During the first stage of the process a tool is employed which resembles the customary rabble, but having a hook which is caused to rest against the inside of the rabble hole in order to obtain a hold against the revolving mass of iron in the pan; the iron is thus agitated rapidly while on the boil. During the "boiling" of the iron a blast may be used, consisting of a thin broad flat current of air, diffused across the surface of the iron in a slanting direction toward the neck of the furnace, and from the side opposite to the rabble hole. When the iron begins to "form," the speed is reduced as required, and the puddler then makes use of another tool, which the inventors call the plough, because it approaches in its shape the form of a ploughshare, and causes a complete turning over, breaking up, and clearing of the iron. When thus sufficiently worked, the iron is balled in the usual maanner, and that either from one or both sides and in balls of any required size.

(114)

DUPUY'S CANISTER DIRECT PROCESS FOR IRON.

EXPERIENCE proves that it is clearly impossible to impart sufficient heat from the outside of a chamber or crucible to accomplish practically, on a large working scale, the results reached by laboratory experiments in the chemist's crucible. Nor can a high column of ore be uniformly penetrated by a blast of reducing gases forced through the mass. As in the German "Stuck" or "Wulf's" oven, the blast pressure necessary to penetrate to the top of a high column of ore, at every operation, will produce a mixture of cast-iron, steel, and wrought-iron, of grades varying from the base upward. A low column of ore will have the atmospheric objections of the forge-fire. It is, further, impossible to maintain a welding heat in the ordinary reverberatory furnace without having the delicate fibres of partially reduced ore largely destroyed by the deleterious gases to which they will be more or less exposed.

To insure an economical, direct method, the operation must not pause with the production of spongy iron. As in the chemists' closed crucible, or in the blast-furnace or forge-fire, the process must go on with a continually increasing heat, until the cells and fibres, produced by the withdrawal of oxygen from the ore, are compressed together and solidified into a cake, at the pasty condition of the metal. It is then a commercial product of wrought-iron, either hammered or otherwise.

How shall this be accomplished? Some years since the writer suggested that rich ores, mingled with the proper proportion of carbon for reduction, should be placed in thin sheet-iron cases of size most convenient to handle. Many of these canisters of ore, to the extent of several tons, placed in a simple cheap furnace, of a peculiar device, in a few hours will become caked and solidified to wrought-iron without further labor, while the encasement will be preserved to the end, the whole to be hammered into a bloom or bar at the same heat.

Deoxidization commences immediately on the introduction of the canister into the furnace, as proved by the blazing of carbonic oxide from them, which continues without intermission until reduction is completed. The heat, which is gradually absorbed, increases in intensity until reduction is effected, and the particles of iron are pasted or matted together; then canister and contents being withdrawn, are welded together by any of the ways puddle ball is usually treated.

The sheet-iron canister or crucible will cost from 20*s.* to 25*s.* to the ton of iron produced. It is a convenient, portable package, keeping the particles of ore in close contact with the exact proportion of carbon required for reduction. It allows the heat to penetrate readily on all sides. It is homogeneous with the new metal, and welds up with it under the hammer. Above all, as it shields and protects the ore from the blast and furnace gases during the whole operation of deoxidization and consolidation, the metal is of superior quality, and is nearly all saved. A series of experiments, extending over many years, confirms the writer in the belief that this process solves the problem of the manufacture of wrought-iron direct from the natural oxides, on any scale of magnitude, and at a cost, both for plant and manufacture, which will effect a great saving over the indirect method. The results of these experiments, in the form of samples of metal taken at all stages of the process, are open to the inspection of any one interested in this subject. (114)

AMERICAN IRON AND STEEL RAILS.

By John B. Pearse, Superintendent of Pennsylvania Steel Works.—In order to get an idea as to the strength of steel rails, it will be well to review the tests to which iron rails have been subjected. In England, Mr. Ashcroft found that the best 80 lb. rails broke under a 300 lb. weight, falling 15 feet. In Germany, the Society of Railway Managers determined on and have long applied a test of 1,000 lbs. falling 10½ feet, as the standard which all first-class iron rails must reach. In this country no inspection or test is applied, but tests made show that iron rails, from our most reliable makers, break under a six-foot fall of a 1,500 lb. drop as an extreme test, most of those tested breaking under a far less test; some breaking with less than a three-foot fall of the same weight.

Everywhere where steel has been used, engineers have come to the conclusion that some test is required to show the regularity and strength of the product. As compared with iron, the tests which steel will stand are wonderful. After numerous experiments, partly based on the experience of the rail-mill at Graz, belonging to the Southern Railway of Austria, the Society of German Railway Managers fixed upon a test of 2,000 lbs. falling 13½ feet. They found that this test represented the steel which suited their necessities, and also found that with steel of otherwise average purity, this test represented about one-half per cent of carbon, and made it a rule to take no steel containing under three-tenths of a per cent of carbon, because it was too soft. They expressed a hope that a harder steel could soon be made tough enough to stand the same tests. In England, a test was adopted of 2,240 lbs. falling 15 to 17 feet on the rail on heavy bearings. This test has been found satisfactory under heavy traffic on average roadbeds, and has been invariably retained by English makers, and adopted by American makers. It is an expeditious practical way of ascertaining the qualities of the rail. Experiment in Germany and experience in England pointed out the test corresponding to the proper grade of steel, and the test adopted has been considered the most practical one.

Rail-making begins with the Bessemer ingot.

The first steel rails made ten years ago were treated like cast-steel. Until 1863 they were made from ingots seven to eight inches square, and four and a half feet long, in four heats. In the first two heats the ingot was hammered down to size, one end at a time, and swaged in dies to the shape of the first pass of the rolls. Then the bloom,

by this time eight feet long, was rolled in two heats through twelve passes into a finished rail.

We now use very large ingots, which necessitate thrice the work formerly applied. In 1867 the ingots were raised in England to ten inches square, and in 1870 to twelve inches square, which is the size in general use. In America we have had exactly the English experience with small ingots, the efforts to use them to advantage having entirely failed.

Seeing, then, that large ingots weighing three-quarters of a ton, and making two rails, have been found necessary, it has become a question as to what mode of working them up gives the best results. I think that hammering furnishes the preferable product, and my present experience goes to justify the opinion. Rolling is preferred by some makers because it is thought cheaper, but I think the better wear of a hammered rail is a strong point in its favor. Rolled rails are generally softer than hammered rails, because their carbon is apt to be partially separated as graphite, and their density is less.

In my own experiments on the effects of the two processes, I compared ingots of the same steel with an average area of respectively about 75 and 110 square inches, average sections, as they were the only molds I had at the time to compare. I found that the rails made of blooms, hammered from the ingots of the latter section, stood over 100 per cent more than the rails made direct from the ingot. The bloom was hammered to the size of the ingot, and each rolled in two heats, one of them a wash heat, into the same kind of rails. I tested in this way 31 different charges. Weight used was 2,000 lbs., bearings two feet apart. The rails from ingots stood 21½ feet fall of this weight, showing 1 $\frac{8}{10}$ inches deflection without breaking. The rails from the blooms stood a 43 feet fall of the same weight without breaking, and showed a deflection of 3 $\frac{9}{10}$ inches. This leaves a surplus of 50 per cent in favor of the hammered rail, deducting 50 per cent for amount due to difference of area of ingots. To show the connection, on a manufacturing scale, of these tests with the actual result, I would remark that we made 13,285 rails out of the ingots of 75 square inches average area. Of these there were rejected by the railroad, for insufficient strength, after delivery, 178 rails, or 1½ per cent. Of the larger ingots we had made, up to the fall of 1870, 34,320 rails, and had rejected for all causes, after delivery, only 18 rails, or $\frac{1}{20}$ of one per cent, or a quantity only $\frac{1}{15}$ as large as before.

We therefore continue to hammer, but now use an ave-

rage section of 150 square inches; doing two-thirds the work under the hammer, and only one-third in the rolls. Our rails thus produced stand a ton weight, falling 17½ feet, and leave an ample margin of reserved strength. We have had recent tests, in which the rail stood what was equivalent to a ton weight falling 70 feet without breaking, but have not yet got up to the armor-plate standard of a mile and a half. Out of a lot of 1,200 tons of 58 and 60 lb. rails, not a single rail, out of the 439 tests given, broke under a ton weight falling 16½ feet. We have since had many similar series.

In regard to the amount produced by the two methods in the same time, the hammer compares very favorably with the rolls. A blooming mill turns out about 55 tons of blooms a day from ingots. We do as much as that daily under a 12-ton hammer, and have done much more than that for a considerable time, so that the relative capacity of the two is hardly decided as yet. In five to six minutes we can hammer down, chip, cut in two, and carry away, a large ingot, reducing it to one-third its former size; and in thirty-five to forty minutes do the whole work of getting a heat of five ingots hammered complete into finished rail-blooms, requiring no subsequent hand-chipping. For three months this hammer did an average of about 70 tons of rail-blooms per day, turning them out sound and well chipped.

As a matter of interest, it may be well to refer to the fact that at Neuberg, in Styria, they use a 19-ton hammer on steel, and according to published statements produce under it in a week only 65 tons out of two furnaces in 11½ turns. They hope, by using four furnaces, to get up to 130 tons a week. It shows well the spirit of American work to compare our product with this. We do now over three times as much as they hope to do, and do it under a hammer of under two-thirds the weight. The weight of ingots is about the same.

In order to show the relative endurance of iron and steel rails, I would like to mention a case that may be regarded as furnishing an American experience of steel rails, equaling that had on the English railroads, and especially on the London and Northwestern. The Philadelphia, Wilmington and Baltimore Railroad laid in their yard in Philadelphia steel rails on one side of the track, and iron rails on the other. The steel rails were hammered rails, and were, with the iron, laid in 1864. The steel rails wore out some seventeen sets of the iron rails, and then the company stopped the experiment, laying steel on both sides.

On a curve of 525 feet radius, steel rails have lasted intact since 1865, and are as perfect as when laid, where iron rails had before lasted only from three to six months.

None of the rails of the Pennsylvania Steel Company, nor of any other company in this country, have ever been worn out by traffic or shifting work, so that, after a five years' experience of American makes, I have reason to believe that they will last at least a generation, under the hardest service.

ABSORPTION OF GAS BY IRON WIRES.

M. D. SEVOZ.—In wire-drawing, when the maker has arrived at a certain gauge, he is obliged, in order to draw the wire finer, to reheat to redness in cast-iron stoves, closed as hermetically as possible, and then to quench in water containing 2.3 per cent of monohydrated sulphuric acid. It often happens that iron wire which has undergone these two operations, for instance, at No. 18 ($\frac{34}{100}$ths of a millimetre), becomes brittle when it has reached No. 8 ($\frac{14}{100}$ths). If the wire is broken, and the fracture plunged into a glass of water, rapid and numerous bubbles of gas are seen to escape. The author has collected this gas, mixed it with air, and obtained a distinct explosion, but has not been able to decide whether it is carbonic oxide or hydrogen. The presence of a small quantity of this gas renders the metal brittle. When the wire-drawers meet with pieces of brittle wire, they ascertain, by putting saliva upon the fracture, whether the brittleness is due to gas. If this is the case they lay the wire aside for five to eight days, when the gas is found to have disappeared, and the wire resumes its ordinary malleability.

GALVANIZED IRON.

THE use of iron coated with zinc (improperly known as galvanized iron), has enormously increased since 1837, when the first English patent was taken out by H. W. Crawford, who applied it chiefly to sheets of corrugated iron, or sheet-iron bent into alternate semi-circular elevations and depressions; this soon became extensively employed for roofing purposes, especially for railway sheds, which were then beginning to be in great request.

The enormous demand that soon sprang up for galvanized iron, especially in sheets, attracted considerable attention in America, and led to improvements in machinery for its preparation, and simultaneously it was adopted as a desirable substitute for wood and stone wherever it could be employed. By various improvements npon Crawford's patent, the effectual coating of sheets, or other articles of iron, was found to render it by far the most

economical means for covering buildings, as it requires no paint and withstands the action of the atmosphere for a very considerable length of time.

There are, besides, other qualities possessed by this material, which render it far preferable to wood or stone for many purposes to which the former is applied, among which its lightness and elasticity, its fire-proof qualities and its great durability, may be mentioned. For cornices, in America, it has almost entirely superseded both wood and stone, the immense weight of stone necessary to give the projection, being one of the principal objections to its use, while the danger to wood from fire, besides its great cost, precludes its employment as a cheap, durable and substantial material. Besides, the absorption of moisture to which American freestone is liable, causes it to scale after damp and frosty weather, while in case of fire it is liable to split and fly to pieces. Its cost, moreover, is about four times as much as that of galvanized iron, while the latter will look better and wear out any quality of stone that may be employed. (106)

IMPROVEMENTS IN TREATING IRON..—E. Kirk makes use of the following composition :

Saltpetre	½ lb.
Concentrated potash	1 "
Borax	¼ "
Sal-ammoniac	¼ "

the above quantities being employed per ton of iron.

These ingredients are pulverized and then thoroughly mixed together, and the resulting mixture placed in cans to prevent the action of the air upon the mixture, and also for convenience of transportation. The compound is introduced into the furnace with the iron or ore and the fuel. The effect of the saltpetre upon the iron or ore is to render the iron more homogeneous in its structure throughout the mass, and to produce the same quality of iron in the whole casting. The effect of the concentrated potash upon the iron is to soften the latter materially, and also act as a flux, yielding a greater amount of metal than could be obtained without its use, the latter effect also being increased by the use of the borax in the compound. The object of the employment of sal-ammoniac is to prevent the introduction of the sulphur contained in the fuel into the iron.

TOUGHENING BRITTLE GOLD.—The most effectual process yet discovered to toughen brittle gold is by simply passing chlorine through the molten metal. By following this method, a saving of one-half in the amount of gold usually set aside each year as unfit for working has been effected.

PYRITES AS A SILVER AND GOLD ORE.—Messrs. Miguel Iglesias & Sons state that although the cupriferous pyrites imported into England from Huelva and the Spanish and Portuguese ports of the Guadiana (chiefly from Pomaron) is very uniform in composition as regards iron, copper and sulphur, yet the silver values of ores from different deposits varies very considerably, the average of one ore being from ½ to ¾ of an ounce of silver per ton of ore, and the average of another being from 3½ to 4 ounces, in each case together with traces of gold. Since the fact has been recognized that these metals can be profitably extracted, many thousand ounces of silver have been recovered, in addition to gold enough to repay the cost of working; and as the plant required is most inexpensive it is greatly to be regretted that the process is not universally adopted. It is certain that during the last ten years silver and gold of a net value of at least a million sterling has been allowed to run away in the waste liquors from metal-extracting processes. (72)

PRECIPITATION OF COPPER.

T. S. HUNT'S process consists in using tin-plate scrap or waste for the precipitation of copper from the solutions obtained in the various wet processes of copper extraction, and in saving in the operation the adhering tin. The copper solution must contain at the same time, chloride of copper and sulphate of soda, or some other base. Such solutions are obtainable from sulphureted copper ores, which have been calcined with common salt, as in the Longmaid or Henderson process, or when similar ores after roasting are digested with chlorides of iron or other chlorides, as, for example, in the Hunt and Douglas process. In case, however, the solutions of copper to be precipitated contain no chlorides, a portion of common salt is added, and in case they contain no sulphates, a portion of sulphate of soda or other soluble sulphate is added. In either case, these salts may equal the amount of copper present. Such solutions, containing both chlorides and sulphates, especially if heated, as is usual in copper precipitation, very quickly dissolve the tin from tinned iron when this is immersed therein, and at once let it fall again as an insoluble hydrated oxide of tin, which may be readily drawn off while suspended in the liquid, and collected by subsidence in proper tanks, to be subsequently treated by methods known to chemists, such as dissolving in hydrochloric acid and precipitating by metallic zinc, by reduction in the dry way, or by conversion into stannate of soda. The scrap-iron thus freed from tin is then employed in the ordinary way to precipitate the

dissolved copper, as metallic or cement copper, from the solutions described. The copper solution, holding the suspended oxide of tin, may be drawn off at once from the iron to the settling tank, and a fresh solution added; or the precipitation of the copper may be carried on without interruption in the first solution till this is exhausted, and the oxide of tin afterward separated from the metallic copper by taking advantage of the greater lightness and the more finely divided state of the former. Should it be desirable to remove the tin from the iron plate without causing an immediate precipitation of copper thereon, this may be effected by mixing a solution of perchloride, or other persalt of iron, with the copper solution.

PREPARATION OF THALLIUM COMPOUNDS.—Flue-dust from the vitriol works is sifted and the powder boiled with dilute sulphuric acid; the resulting pasty mass is filtered, the residue being well washed with hot water and the washings used for a fresh portion. On boiling down the first filtrate to the crystallizing point, thallium-aluminium-iron separates in fine red crystals; these are recrystallized from dilute sulphuric acid, and then either converted into thallium chloride by means of hydrochloric acid, or reduced to metallic thallium by means of zinc and sulphuric acid. The mother-liquors of the alum may be precipitated by means of hydrochloric acid, and the thallium chloride thus obtained converted into sulphate and then into thallium-aluminium-alum, which is purified by recrystallization and treated as before. Thallium alum is much more soluble in hot water than in cold, and is hence readily crystallized.

NITRATE OF SILVER.—R. Palm obtains pure silver nitrate from silver alloyed with copper by the following process: The alloy is dissolved in nitric acid, the solution concentrated to the consistency of syrup, and mixed with strong nitric acid. The silver nitrate crystals precipitate on the addition of the acids, while the copper is left in solution. Repeated washing of the crystals with concentrated nitric acid frees them from every trace of copper.

SOFTENING STEEL.—W. R. Lake proposes to soften steel by heating to a cherry red, covering with common salt, and then working into the required shape. The articles are then sprinkled with a mixture of common salt, sulphate of copper, sal-ammoniac, saltpetre, and alum, heated to redness, hammered, again sprinkled with the mixture, and so on till finished; finally, they are hardened in a solution of the same mixture.

FIRE-BRICKS.

FIRE-CLAY derives its valuable properties from the presence in combination of two special constituents—silica and alumina—of which the former predominates, forming, in the majority of instances, about two-thirds of the whole, and its quality is enhanced in proportion to the absence of other constituents, the alkalies especially, which diminish its refractory power. Of these deteriorating elements, peroxide of iron is the most detrimental, and indeed may be regarded as the chief cause of the wear and waste under heat of fire-bricks, etc.

In Cornwall some new deposits of fire-clay have been found, composed as follows:

Silica	67.51 per cent.
Alumina	24.97 "
Iron	a trace.
Moisture and combined water	6.08 "
Lime	a slight trace.
Magnesia	0.64 per cent.
Alkalies	0.80 "
	100.00

Fire-bricks made therefrom possess all the characteristics and qualifications for such uses; they have been tested in blast and other smelting-furnaces, and found to possess powers of resistance and endurance under great heat in a very remarkable degree. The great freedom from iron probably conduces largely to this result. (106)

IMPROVEMENT OF THE BUNSEN BURNER.

BY F. KINGDON.—The students in the Physical Laboratory of Owens College, having occasionally experienced some difficulty in obtaining the spectra of some salts with the ordinary Bunsen, through apparently a deficiency of pressure in the gas, it occurred to me that the amount of light even at this deficient temperature might be increased by multiplying the number of luminous points. This is accomplished by broadening out the flame of the Bunsen, that is, causing the gas to issue through a narrow slit instead of a round hole. We have, so far, only made a rough experiment, the slit being about $\frac{1}{4}$ inch long, and $\frac{1}{8}$ inch wide. The result is, as expected, a more brilliant spectrum.

ALLOY FOR MUSIC-PRINTING PLATES, ETC.—Jean makes the preparation of the following alloy, to which he gives the name "heterogeneous metal":

Tin	10 parts.
Zinc	12 "
Antimony regulus	3 "
Copper	1 "
Lead	74 "

ACTION OF LIGHT ON VANADIUM COMPOUNDS.

BY JAMES GIBBONS.—Potassium divanadate, in combination with organic matter, is first rendered green, and ultimately blue, by exposure to light, being reduced probably to the state of vanadium tetroxide. The salt is not sensitive to light in the absence of organic matter.

Gelatine, mixed with potassium divanadate, becomes slightly less soluble in warm water after being exposed to light; this is apparent by the unexposed portions of the film swelling and dissolving more quickly when treated with water than the exposed parts.

If a colorless film of dry sodium orthovanadate (Na_3VO_4), free from organic matter, be exposed on glass to the sun for several hours, it only acquires a faint brown tint. The film kept in the dark, with access of air, for some hours, regains its normal colorless condition. The salt does not undergo any change when exposed to diffused daylight.

Paper which does not contain any size of an animal origin, when coated with a solution of sodium orthovanadate, is darkened on exposure to light, the depth of tint depending on the length of exposure and on the strength of the solution used. The tint, however, never becomes darker than a slate color.

If the paper thus prepared be immersed, after exposure to light, in a solution of silver nitrate, the color in the exposed part instantly changes to a deep brown or to a black color, varying according to the amount of exposure. A tint of the decomposed vanadate, which is of so slight an amount as to be with difficulty distinguished from the whiteness of the paper, will, by immersion in the silver nitrate, be toned so as to exhibit a very perceptible tint.

It is evident that paper prepared in this way might be employed for the purposes of photographic printing.

The unexposed parts are converted by treatment in the silver bath, into yellow silver vanadate. This substance may be dissolved out either by ammonia or by sodium hyposulphite. This act of fixing converts the dark brown or black part into those of a red color. This may be prevented to some extent by using a bath of ammonio-silver nitrate, with an excess of ammonia, instead of the simple silver nitrate bath. The developed print can afterwards be toned with gold chloride.

The length of exposure required to produce a deep black is about one hour to a strong sunlight. This by using a solution of the sodium orthovanadate containing about 11 per cent of the salt.

Some ligneous substance only must be present with the sodium orthovanadate for the production of the above-mentioned slaty tint; for if an albuminous body be present, a faint brown tint is produced after exposure to light, and the silver nitrate is not afterward reduced to any very great extent. The slate color of the reduced salt appears to be due to the formation of vanadium trioxide. If the exposed paper be kept for some weeks, its color changes to that of a yellowish brown, free vanadic acid appearing to be produced.

Gelatin impregnated with sodium orthovanadate exposed to light, and afterwards dipped into a solution of silver nitrate, becomes insoluble in hot water.

Silver orthovanadate is capable of forming a photographic image, which is nearly latent, and which may be developed by the ordinary ferrous developer used in photography.

To produce this image two or three minutes' exposure to sunlight is required. To develop it, it is essential that little or no silver nitrate be present; otherwise, the exposed and unexposed parts are reduced indiscriminately. The washed silver vanadate can be mixed with a solution of gelatine containing a little albumen, spread upon paper, and allowed to dry; it can then be exposed to light, and afterwards developed.

MANUFACTURE OF CHLORINE AND OF AMMONIA.

TESSIÉ DU MOTAY treats a mixture of

Sodium chloride	3 equivalents.
Ditto nitrate	1 "
Sulphuric acid	4 to 5 "

in cylinders of cast-iron or other suitable material; chlorine and nitrous gases are evolved, and are passed over cuprous chloride, which becomes converted into cupric chloride, nitric oxide passing on; this latter is then mixed with hydrogen and passed over pumice-stones impregnated with platinum or oxide of iron at a dull red heat; water and ammonia are thus formed. The cupric chloride when heated to 200°–300° splits up into free chlorine and cuprous chloride, which is employed over again.

In another process, aqua regia is produced by mixing

Hydrochloric acid	3 equivalents.
Nitric acid	1 "

To this are then added

Cuprous chloride	6 "

when cupric chloride is produced, together with nitric oxide, which is collected in gas-holders.

METHOD OF TESTING GLYCERINE.

BY DR. RICHARD GODEFFROY.—As is known, pure glycerine should be free from color and smell, neutral, of specific gravity 1.26 to 1.27, capable of mixing with alcohol and water in all proportions, and free from all foreign substances.

The methods published for the examination of the purity of glycerine are somewhat tedious, for the glycerine must be tested not only with regard to its specific gravity, but also by means of all possible reagents for finding out of impurities which might be present. I believe that now I have found a method by means of which some of the testing operations are much simplified.

If pure glycerine be placed in an open platinum or porcelain crucible, and heated up to 150° Celsius, it will begin to boil. It can now be ignited and will continue to burn quietly with a blue and not very luminous flame, without diffusing the least smell or leaving behind it the least residue.

When the glycerine has a specific gravity below that of pure glycerine, it will boil under 150° Celsius, but at the moment of boiling it can not be ignited.

If metallic salts be mixed with the glycerine they will remain as residue in the dish; the same would be the case when more highly organized combinations are present; these remain in the cup as a black, charred, or soot-like residue.

I may mention that glycerine can be ignited very easily by means of a cotton wick, and continues to burn without smell; on extinguishing the flame there is no smell. The ordinary commercial glycerine of specific gravity 1.249 to 1.256 can easily be ignited by means of cotton: it is not necessary in this mode of ignition that the glycerine be anhydrous. (65)

FERMENTATION OF FRUITS.—MM. G. Lechartier and F. Bellamy have submitted cherries, gooseberries, figs, lemons, cherry and gooseberry leaves, chestnuts, and barley to experiments similar to those already performed with apples and pears. The results were identical. They draw the following conclusions: At the moment when the fruit, the grain, or the leaf is severed from the plant, life is not extinct in its component cells. This life is accomplished, in the exclusion of air, in the consuming sugar, and in producing alcohol and carbonic acid. As soon as the production of the latter ceases all vitality is extinct in their cells. Fruits, seeds, and leaves may therefore remain indefinitely in an inert state if no organic ferment is

developed in their interior. Beet-roots and potatoes present a special phenomenon. As regards the production of alcohol and carbonic acid, they behave like fruits. They do not contain any alcoholic ferment, but in the acid liquid which saturates the mass of their softened tissues, the authors have recognized bacteria of different sizes.

PREPARATION OF PURE CHLORINE GAS.—F. Stolba effects the purification of chlorine by washing it as it leaves the generating flask, with a somewhat concentrated solution of copper sulphate, and subsequently with water. The copper salt solution has a strong tendency to retain hydrochloric acid, while it allows free passage to chlorine. The gas to be purified must be conducted as slowly as possible through the copper sulphate solution, in which numerous pieces of pumice-stone float, thus affording a large surface.

MANUFACTURE OF OXALIC ACID.—Tessié du Motay mixes beet-root pulp with 60 per cent of caustic soda, or of a mixture of caustic soda and potash dissolved in a bulk of water equal to the total volume of the mass. The whole is then heated in an oven to 200° to 230°; the oxalate of soda formed is crystallized to separate carbonate, and is then decomposed by lime, whereby the alkali is regenerated. From the oxalate of lime formed, oxalic acid is extracted by the ordinary process. (22)

PREPARATION OF CUPROUS CHLORIDE.—Boettger prepares cuprous chloride expeditiously by adding to a solution of cupric chloride one of stannous chloride; stannic chloride is thus formed, together with cuprous chloride, which separates as a sparingly soluble precipitate; this is collected, and slightly washed with water.

SEA-WATER ICE.—J. G. Buchanan states that pack-ice from the Antarctic regions contains a considerable amount of salt, also lime, magnesia, and sulphates, the average amount being equivalent to 0.1723 grammes of chlorine per litre of water (after melting); a specimen of ice from sea-water, frozen in a bucket, contained about 9 times as much. The presence of the salt in the ice lowers its melting point by about 1° C., and the water obtained on melting is too salt to be used for drinking purposes.

PURE GOLD.—W. Chandler Roberts states that perfectly pure gold is obtainable by reducing gold chloride by oxalic acid and fusing in a clay crucible with bisulphate of potash and borax. The gold obtained by electrolyzing the double cyanide of gold and potassium contains 999.90 of fine gold per mille, whilst the product of the reduction of the chloride with sulphate of iron and subsequent fusion contains only 999.85 per mille.

PREPARATION OF CHROMIC ACID.

By Oscar Ficinus.—Warington's method of preparing chromic acid (which consists in mixing 1 vol. of a cold saturated solution of potassium bichromate with 1½ vol. of strong sulphuric acid) often fails, owing to the acid employed not being strong enough, in which case no separation of chromic acid takes place. The addition of more sulphuric acid throws down only a small quantity of chromic acid in red flocks. It is better, therefore, to evaporate the liquid over the water-bath till a small portion placed on a watch-glass crystallizes on cooling, and then to allow the whole to stand for two days, whereby fine crystals are obtained.

When chromic acid is to be prepared frequently, the author prefers to use the residual sulphuric acid from a previous operation; it is then only necessary to evaporate somewhat longer over the water-bath. On using the same acid a third time, a little potassium bisulphate crystallizes out with the chromic acid.

For preparing chromic acid once only, 1 part of a cold saturated solution of potassium bichromate may be mixed with 1 part of strong sulphuric acid, and the mixture evaporated over the water-bath. In this way a considerable saving of sulphuric acid is effected, while the product is as abundant, and as well crystallized, as that obtained by Warington's method.

The author attempted to prepare chromic acid from barium chromate and sulphuric acid, but did not succeed in obtaining a product crystallized in needles.

SEBACIC ACID.

By O. N. Witt.—To prepare sebacic acid, castor-oil is mixed with an excess of concentrated soda, and the mixture heated for some hours to 40°. The soap is then powdered, dried, and heated, with frequent stirring, as long as octyl alcohol is given off. As soon as it begins to assume a brown color, it is poured into cold water. If this be not done, or if the mixture be heated longer, it melts, inflammable stinking gases are given off, and instead of sebacic acid, a brown amorphous insoluble acid melting at 45° to 50° is obtained. Most of the sebates of the heavy metals are insoluble precipitates. On adding freshly precipitated cobalt carbonate to a boiling solution of sebacic acid, it dissolves, and on cooling the excess of sebacic acid crystallizes out. On evaporating the filtrate, the salt $C_{10}H_{16}O_4Co+2H_2O$, separates in rose-colored crusts, and by spontaneous evaporation it is obtained in globules consisting of microscopic needles, or in larger ruby-red

transparent prisms. It is quite insoluble in water, alcohol and ether; at 120° it loses the greatest part of the water, and assumes a beautiful violet color, the remainder of the water escaping only at a higher temperature, at which the salt begins to decompose. By evaporating the solution rapidly, the anhydrous salt was once obtained in beautiful violet crystals.

LIQUID CARBONIC ACID.—Cailletel has succeeded in liquefying carbonic acid, under conditions which enable him to test many of its properties while still in the liquid state. His apparatus consists of a hydrostatic press, by which mercury can be forced, under a pressure of 900 atmospheres, into a cylindrical glass reservoir, terminating in a narrow thick tube. Liquid carbonic acid he finds to be colorless, mobile, and a non-conductor of electricity. It is not decomposed by a powerful induction spark, but the spark has, in the liquid, a very white, dazzling appearance. Salt, sulphate of soda, chloride of calcium, sulphur, phosphorus, stearin, and paraffin are quite insoluble in liquid carbonic acid. Iodine is slightly soluble. Liquid carbonic acid is but slightly soluble in water; petroleum, however, dissolves five or six times its bulk. Bisulphide of carbon dissolves in it sparingly. Ether mixes with it, in all proportions, with great readiness. Liquid fats dissolve in it, but not solid fats. Sodium does not reduce it.

VALVE FOR GASES AND CORROSIVE LIQUIDS.

THIS valve is adapted to cases where liquids have to be forced into vessels under pressure. A piece of glass tube about 3″ long and $\frac{3}{16}$″ internal diameter has a bulb blown in the middle, and the ends are cut off square. A piece of india-rubber tube 3″ long, and of such a thickness that it will just pass into the bulb-tube, has one end tied with a string or platinum wire. Just below the ligature a transverse slit is made, so that the end is nearly cut off. The uncut part serves as a hinge. A small pellet of cork or india-rubber is put into the end beyond the slit. The tube is then stretched on a piece of glass tube, and the whole forced into the bulb-tube, till the valve occupies the interior of the bulb. Any pressure in the tube raises the valve on its hinges, while any back pressure closes it tightly. For pressures up to 30 lbs. on the square inch it is perfectly air-tight. Beyond this the author has not tried it.—*Chemical News.*

TO AVOID EXPLOSIONS WITH HYDROGEN GENERATORS.—Adapt a safety-jet made of discs of wire gauze placed in the delivery tube between plugs of cotton wool.

CHLORIDES OF BORON AND SILICON.

BY H. SCHMITZLER.—The difficulty of preparing boron chloride is great, even in very small quantity, with the use of a strong freezing mixture. This difficulty was overcome by using a tube about 6 inches long and 1¼ wide, and so inclined that the course of the boron chloride and that of the stream of chlorine should be opposite. The tube lies in a wooden gutter, enveloped in snow, over which strong hydrochloric acid is poured from time to time. The temperature was about 10°. The preparation was accomplished by means of an ignited mixture of boracic acid, soot, and oil, in a mass of spherical form, placed in a porcelain tube in the usual way. The stream of chlorine should be strong, if the temperature is very high. In one afternoon the author obtained about 80 c.c. of faintly yellow-colored boron chloride.

Silicon chloride requires a somewhat lower temperature, the condensation taking place conveniently in a U-tube, on account of its being less volatile. As a freezing mixture, a mixture of snow or pulverized ice with concentrated sulphuric acid, is serviceable. The sulphuric acid is mixed with so much snow, that the temperature rises to 50° at the highest; the mixture is then allowed to cool, and mixed with cold snow. In two days about 200 grains of chloride were obtained. After treatment with mercury, and removal of hydrochloric acid vapors, the substance is rectified in a special apparatus, a fluid as clear as crystal being obtained. (36)

A NEW ALKALOID FROM MORPHINE.

G. NADLER has obtained an alkaloid by the action of ammoniacal solution of oxide of copper on morphine, the chlorine-compound of which is dazzling white, sparingly soluble in cold, but easily soluble in hot water, and insoluble in alcohol and ether. The aqueous solution gives with ammonia a dense, white, amorphous precipitate, which does not alter in the air while moist, but dries up, like aluminium hydrate. Ferric chloride produces in the aqueous solution an amethyst-red color, which rapidly darkens. Strong sulphuric acid dissolves the alkaloid on warming, forming a dark-green solution, which does not alter when heated sufficiently to volatilize the acid. Blue ammoniacal copper solution assumes a splendid green color. Potash, like ammonia, produces in the aqueous solution a curdy precipitate, which, however, dissolves in excess in the cold. In this respect the alkaloid resembles morphine. The potash-solution, when heated to boiling, deposits the alkaloid in silvery scales. The alkaloid rap-

idly reduces silver-nitrate, and gives with platinic chloride a pale-yellow platinum-salt. Dilute sulphuric acid throws down from the solution in hydrochloric acid a white, amorphous sulphate. The new alkaloid is distinguished from morphine by being precipitated in the amorphous state by ammonia, by its behavior with ferric chloride, ammoniacal copper solution, potash, and strong sulphuric acid, and by the sparing solubility of its sulphate; and from apomorphine by the fact that in the moist state it does not become colored on exposure to the air, but remains perfectly unaltered.

JERVINE.

By C. L. Mitchell.—This alkaloid, first obtained by Simon from the root of *Veratrum album*, has been found by the author to exist also in *V. viride*, from which it may be prepared pure by the following process: The finely powdered root is thoroughly exhausted with strong spirit, and the tincture is evaporated to a small bulk, acidulated with acetic acid, and mixed with water. The resin thereby precipitated is separated by filtration; the filtrate is concentrated, and rendered strongly alkaline with sodium carbonate; the resulting precipitate is dried, and boiled with strong spirit, till nothing more is dissolved; the alcoholic solution is evaporated to dryness; and the residue digested in hot, very dilute sulphuric acid. The granular powder which separates on cooling is jervine sulphate, which, after washing, is decomposed by boiling it with strong solution of sodium carbonate. Jervine then separates as a granular powder, which is washed, dissolved in acetic acid, and again precipitated by ammonia.

When a minute fragment of jervine is moistened on a glass slide with a drop of strong sulphuric acid, it changes first to a straw-yellow, and then gradually to a green color. This reaction is characteristic and delicate.

Arsenic in the Air of Rooms.—The statement that the air of rooms painted with green colors prepared with arsenic, contains the latter in quantities sufficient to induce serious, or even fatal, effects in persons inhabiting those rooms, has been doubted, on the ground that the oxygen compounds of arsenic are not volatile at the ordinary temperature. Flack finds that the green color known as Schweinfurt green yields in a moist atmosphere *arseniureted* hydrogen. The organic substance, starch, etc., used for fixing the color, favors the formation of that highly volatile poison.

DERIVATIVES OF THE ORCINS.

BY J. STENHOUSE.—*Moniodorcin*, $C_7H_7IO_2$, is prepared by dissolving 1 part of orcin and 2 parts of iodine in 6 parts of ether, and gradually adding 9 parts of finely powdered litharge. The color of the solution rapidly disappears, and heat is developed. On distilling off the ether, and exhausting the residue with hot benzine, the iodorcin separates in the crystalline state on cooling. When pure, it forms colorless prisms which melt at 86.5° and decompose with evolution of violent vapors of iodine when heated. It is only slightly soluble in cold water, but readily in hot water, the substance undergoing decomposition when the solution is boiled. It is very soluble in ether and alcohol, moderately so in benzine and in hot petroleum, slightly in carbonic disulphide. It is quite destitute of the peculiar astringent sweet taste so characteristic of pure orcin. Mercuric oxide may be employed instead of lead oxide in its preparation, but, from the solubility of mercuric iodide in most liquids, it is not so advantageous.

Moniodoresorcin, $C_6H_5IO_2$, is prepared similarly to the corresponding orcin compound, by adding 110 parts of lead oxide to 10 of resorcin, and 24 of iodine in 60 of ether. It crystallizes in rhomboidal prisms, which melt at 67°, and are very difficult to obtain colorless. It is much more soluble in water than iodorcin, and very soluble in alcohol and ether. In its other properties it very closely resembles iodorcin.

In preparing teriodorcin by the action of iodine protochloride on orcin, it was observed that a comparatively large amount of the dilute solution of iodine chloride could be added to the orcin solution before a permanent precipitate of teriodorcin was produced, and it seemed possible that an intermediate iodine derivative was first formed, far more soluble than the teriodorcin. The attempts, however, to isolate this compound proved unsuccessful.

FROM the experiments of W. F. Donkin, it appears that the Sprengel pump may be made to give an exhaustion down to $\frac{1}{70,000,000}$ in its simplest and most convenient form, namely, without an air-trap and with an india-rubber joint immersed in glycerine; but if a very complete exhaustion is required, the air-trap must be used, and the vessel to be exhausted must be sealed hermetically on to the pump.

BONE CHARCOAL.—Compact bones, such as marrow bones, give more charcoal, and of better quality, and yield less ammonia, oil, and gas; while the reverse holds with light bones.

THE SPONTANEOUS COMBUSTION OF CHARCOAL.

PROFESSOR HARGREAVES states that the kinds of wood generally used for the manufacture of gunpowder charcoal are the black dogwood, the willow, and the alder. They are all well adapted for the manufacture of charcoal, although the dogwood is always used for the best sporting gunpowder. The wood is converted into charcoal by heating it in iron cylinders.

After the charcoal is taken from the cylinders, it is placed in iron coolers provided with tightly-fitting lids, and allowed to stand for 24 hours, by which time it is generally quite cold, when it is sent to the charcoal mill to be ground, and afterward to be mixed with the other ingredients for gunpowder.

But there are examples where the charcoal has spontaneously taken fire, one day after grinding. This is owing to the fact that charcoal absorbs mechanically within its pores a large quantity of oxygen gas from the atmosphere, and the condensation of all gases liberates heat, and charcoal being a bad conductor, the heat can not escape. The amount of oxygen absorbed by the charcoal varies with the degree of carbonization; the higher the heat the more gases will it absorb.

The absorption with sticks of charcoal is not so quick as with ground charcoal: hence the spontaneous combustion of stick charcoal does not occur so often.

A LECTURE EXPERIMENT WITH POTASSIUM.

BY H. KAEMMERER.—To show the green color of gaseous potassium, it is volatilized in wide horizontal tubes through which hydrogen passes, which becomes spontaneously inflammable, and burns with a brilliant violet flame, while the hot part of the tube becomes filled with the green vapor, condensing in the colder parts as a mirror. When the experiment is finished and air gradually admitted, the potassium is first oxidized to the blue quadrant-oxide.

ZINC CRYSTALS. BY S. P. SHARPLES.—A thermo-electric pile having been in use for about a year, some of the plates—which consisted of an alloy of zinc and antimony—were found to be covered with a moss-like growth at the end farthest from the point to which heat had been applied. This moss was proved to be metallic zinc; under the microscope it was found to consist of long ribbon-shaped crystals, deeply striated in the direction of their length.

AGGLOMERATION OF METALS BY HYDROGEN.

I PLACED a piece of zinc, says the author, Alfred Tribe, in contact with some purified copper-black covered with dilute sulphuric acid (3 per cent). Hydrogen was at once evolved, and almost immediately the metallic particles near the zinc became agglomerated.

The negative platinum electrode of a battery was then placed in contact with some copper-black in acidulated water, when, on immersing the positive pole in the liquid, the metal in the vicinity of the escaping hydrogen again agglomerated.

In both experiments the aggregated copper was somewhat of a chocolate color, and in portions of that produced by the electrolytic hydrogen, it was decidedly coppery.

Palladium.—It now appeared of interest to ascertain whether hydrogen would produce the agglomeration of the finely divided particles of those metals which are already known to condense it. The readiness with which palladium can be obtained in a finely divided state, coupled with its great power of condensing hydrogen, induced me to select it for experiment. It was jet black, and in an extremely fine state of division.

I placed some of this palladium in a watch-glass, and covered it with dilute sulphuric acid, which produced no change in its aggregation. When, however, it was touched with zinc, the agglomeration took place, and this without any change in color of the metal.

Some palladium on the negative platinum electrode of a battery was now placed horizontally at the bottom of a vessel containing acidulated water, the positive electrode being near the surface of the liquid. It could be seen that almost immediately the aggregation of the metal had taken place, and that without change of color.

Platinum.—This metal was also prepared in a finely divided state by heating a dilute solution of it with potassium formate. It was grayish-black, and agglomerated easily when acted on by hydrogen, like palladium, although not so readily.

Some palladium was next placed on the *positive* platinum electrode of a battery immersed horizontally in acidulated water. Oxygen was abundantly evolved, yet not a trace of agglomeration took place. The current was now reversed, and the finely divided metal began at once to agglomerate. On again reversing the current, I was gratified to find that the agglomerated palladium-black de-agglomerated.

Graham, in his researches on the "occlusion of hydrogen by metals," found that the gas could be readily extracted from palladium by reversing the latter in the decomposing cell of a battery, and also that neither palladium nor platinum absorbs oxygen. The reason, therefore, that oxygen does not produce the phenomenon, but actually reduces the agglomerated metals to their original condition, is doubtless because, in the first place, it is not condensed; and secondly, that it combines with the condensed hydrogen on which the agglomeration depends.

Hypothesis.—That the agglomeration is due to a property perhaps specific to hydrogen, there can be no reasonable doubt, and the explanation which has presented itself to me is, that the minute metallic particles, in virtue of a species of adhesive attraction, become surrounded by films or layers of hydrogen, the coalescence or partial coalescence of these films producing the spontaneous inward movement of the finely divided metal which is characteristic of agglomeration.

The comparative ease with which the agglomerated metals weld or burnish is probably due to the closer approximation of the metallic particles, and also, perhaps, to liquid particles, and also, perhaps, to liquid hydrogen being less viscous than water.

Mr. Oakley-Coles, while experimenting on the applicability of agglomerated platinum for dental purposes, found that it very readily combines with mercury, forming an amalgam which becomes solid in a few hours.

NEW METHOD OF DETECTING MERCURY.

MAYENÇON AND BERGERET give a method consisting in placing an iron nail, to which a platinum wire is attached, in the urine, etc., acidulated with so much sulphuric acid as to cause a slow evolution of hydrogen. The mercury is deposited in the metallic form upon the platinum, which is taken out after the lapse of half-an-hour, washed, and exposed to a current of chlorine, to convert the mercury into corrosive sublimate. The wire is then gently drawn over blotting-paper slightly moistened with a one per cent solution of potassium iodide. If mercury is present, red streaks of mercuric iodide, soluble in potassium iodide, are formed. The method is very delicate and rapid. The authors could always detect mercury in the urine (but not in the saliva, notwthstanding that salivation had taken place) after the internal administration of corrosive sublimate, or inunction with mercurial ointment. They also found mercury in abundance in the milk of a woman 48 hours after inunction.

METEORIC IRON.

THIS meteoric iron, from Mount Descubridora, near Poblazon, in Mexico, the origin of which is unknown, appears, says Dr. Burkart, to have originally formed a mass of pyramidal shape, and weighing about 18 cwt.; but it has been broken into several pieces. Its color on the parts which have been exposed to the air, is brownish-black; on other parts, where schreibersite appears to have been exposed, it is silver-white, and on the recently fractured surface, whitish steel-gray; it shows a distinctly crystalline structure, has for the most part a faint metallic lustre, but is dull on the oxidized surface. It is flexible and malleable, of sp. gr. 7.38 and hardness 8; attracts both poles of the magnetic needle. In the interior of the meteorite are a few cavities, filled with a crystalline, earthy (?) mass, having a speiss-yellow color passing into pinchbeck-brown, and metallic lustre, either Haidinger's troilite or sulphide of iron.

The compositon of the meteorite, according to an analysis by P. Murphy, is—

Iron	89.51
Nickel	8.05
Cobalt	1.94
Sulphur	0.45
Traces of chromium and phosphorus, and loss	0.05
	100.00

On etching a polished surface with nitric acid, Widmanstatt figures are produced, similar to those exhibited by the meteoric iron of Xiquipilco.

CHROMIUM AND CHROME-IRON.

THERE are immense deposits of chrome-iron in Sonoma County, Cal., and it is now being shipped east. At the manufactory it is worth from $40 to $60 a ton. Chromium is extracted from iron stone, named from its tendency to impart useful and beautiful colors. Chromium compounds are used in photography, in printing, and in dyeing. The brilliant green color used on legal tender notes is a chromic oxide. The same pigment is used in staining glass and painting porcelain. The base of all its combinations is the common yellow chrome of commerce. One of its combinations, a chromic chloride, is said to possess virtue as a remedy for cancer. Witter Springs, in Lake County, may owe its peculiar virtue in cancer to this ingredient in its waters, as it is surrounded by deposits of chrome-iron.

Chromium steel is made by combining five per cent of chromium with cast-iron. On account of its excessive hardness it is used in the construction of safes. It has

also great tensile strength, and is extensively used in the construction of suspension bridges.

In the United States the only chrome-iron mines worked are in Maryland, near Baltimore.

HYDROCARBONS FROM CAST-IRON AND STEEL.

By J. Dumas.—Knowing that when a metal, in combination with a non-metallic element, is submitted to the action of a hydrogen-acid, the metal combines with the negative element of the acid, while the non-metallic element unites with the hydrogen in the proportions in which they are liberated, it might be possible, from the nature of the hydrogen-compound formed, to determine from what metallic combination it was derived. Those bodies, obtained by the action of hydrochloric acid on pig-iron, of which Cloez has determined the composition, belong to the C_nH_{2n} series, and it may, therefore, be inferred that they are derived from a carbide of iron FeC, which by the action of water and an acid would give $FeO+CH_2$; and this by condensation would give sundry polymerides of the C_nH_{2n} series. It might be inferred therefrom that white cast-iron and chilled steel contain in solution more or less of the carbide FeC, while gray cast-iron and unchilled steel contain less of that carbide, and so exhibit the larger proportion of their carbon as graphite. If several C_nH_{2n} hydrocarbons are formed, it is probable that several carbides are present. In any case this formation of definite hydrocarbons places the reaction among those observed when the same acids are made to act upon ordinary binary compounds, the sulphides, for example. The author then remarks that the formation of definite organic bodies, by simple contact of carbon and hydrogen in the nascent state, still further narrows the limit between organic and mineral chemistry, properly so-called. (4)

THE EFFECT OF ACID ON WIRE.

By Osborne Reynolds.—Some iron and steel wire which had been acted upon by sulphuric acid were found to have become altered in their properties. Though soft charcoal wire, it had become short and brittle, the weight had increased, and when a specimen was broken and the fractured end was wetted with the mouth, it frothed up as if acted on by a powerful acid. These effects were not permanent.

The explanation given by Mr. Johnson, who first observed these phenomena, is not the correct one. They are due to hydrogen which has entered into the iron.

The author took a piece of iron tube, and having closed

it at one end, immersed it in dilute sulphuric acid; hydrogen was found to pass through into the interior of the tube, and could be collected by connecting the open end of the iron tube to a glass one by means of india-rubber. It is probable that iron becomes saturated with hydrogen whenever oxidation goes on under water, and if so, the fact of the metal being thus rendered brittle is an important question in the case of iron boilers and ships. (2)

DETECTION OF METALLIC POISONS.

By Verryken.—The novelty of this method consists in the destruction of the organic matter by oxygen gas in a combustion tube. The tube is heated to redness, except at the spot where the substance is placed, and oxygen, washed with sulphuric acid and filtered through asbestos or cotton-wool, is passed in so slowly that actual ignition does not occur. After complete oxidation, the tube is washed out with boiling nitric acid. The method has successfully detected $\frac{1}{40,000}$ of copper, $\frac{1}{50,000}$ of lead, mercury, arsenic, or antimony, when about 10 grammes of the organic matter were used in each case.

In using Marsh's test, the author passes a slow current of pure hydrogen from a gasometer through the evolution flask. This device enables the size of the flame to be regulated.

NEW SYNTHESIS OF GUANIDINE.

By G. Delitsch.—When ammonium sulphocyanate is heated for two hours to 190°—200°, the sulphurea which is first formed is converted into guanidine. The residue is purified by recrystallization from water; a small trace of sulphurea sticks obstinately to it; its presence is easily shown by adding thallium oxide to the solution, which produces black flakes, while, when the guanidine salt is pure, a white precipitate of thallium sulphocyanate is formed, which dissolves on heating and crystallizes on cooling in colorless needles having a metallic lustre. Pure guanidine sulphocyanate forms large, colorless, flexible plates, having a peculiar fatty lustre; it melts at 118° and solidifies again to glistening crystals. Aqueous soda acts slowly on it, but a cold potash-solution decomposes it into potassium sulphocyanate, urea, and ammonia.

As this salt is so easily obtained, it is the best material for the preparation of other guanidine-salts. The nitrate is obtained by evaporating a concentrated solution of the sulphocyanate and potassium nitrate, and exhausting the residue with cold alcohol.

It is sparingly soluble in alcohol and cold water, more freely in boiling water, and crystallizes in soft scales, grow-

ing together to long plates, and consisting of microscopic tetrahedrons with obtuse summits. To obtain the sulphate, the sulphocyanate is decomposed with copper sulphate; it is so soluble that it solidifies only when all the water has been evaporated. By adding baryta-water to its solution, saturating the liquid with carbon dioxide and evaporating, the carbonate is obtained, which is also very soluble, and forms crystals resembling sal-ammoniac and belonging to the regular system.

BEHAVIOR OF DIAMOND AT HIGH TEMPERATURES.

By V. Schrötter.—A perfectly transparent and polished diamond, in the form of a rhomb, slightly injured at the edges, was placed in the middle of a Hessian crucible filled with calcined magnesia and covered with a porcelain lid; this was inclosed in a second crucible, the intervening space being filled with graphite, and the whole was exposed to the highest temperature of a porcelain kiln. After cooling, the diamond was somewhat dull on the surface, but showed no trace of blackening or turbidity within. But on repeating the experiment with the diamond wrapped in platinum-foil, it was found that the platinum, which was fused to a globule, had taken up carbon, and the diamond was totally altered in appearance. The surface was slightly blackened, and the interior exhibited black dendritic markings. The black of this diamond was a pure black, like amorphous carbon, whereas natural black diamonds have always a more or less dark-brown appearance. The density of the diamond was reduced from 3.48 at 18° to 3.473 by heating in magnesia, and further to 3.458 by heating in contact with platinum.

Preparation of Lithium. By H. Schnitzler.—A mixture of fused lithium chloride with ammonium chloride in a large porcelain crucible, is reduced by means of a battery of 12 Bunsen's elements. The fusion of the chloride is best accomplished with a good 24-burner. From the iron wire forming the negative pole, the accumulating drops of lithium can then be removed by raising the wire with a small iron spoon, and shaking off the lithium into petroleum, where it assumes a spherical form. Globules were thus obtained one centimeter in diameter, free from adhering lithium chloride. The lithium in an iron mold can be drawn through a fine orifice to a wire of silvery lustre. The metal fused in a glass tube and floating in petroleum is an interesting object. In a day more than 25 grains can be prepared as above. (36)

NEW WET PROCESS FOR COPPER.

BY PROF. T. STERRY HUNT.—Copper is generally got from its ores by smelting in furnaces, but for centuries it has been known that, by means of acids, it can be dissolved from its oxidized or calcined ores, and from the solutions thus obtained, thrown down by iron in a metallic state, a cheaper mode of making it soluble was sought, and by roasting the ores if sulphurous with sea salt, it was found that the copper could be got as a soluble chloride. This process is largely used, and offers great advantages, especially for ores holding a small percentage of copper; but the consumption of metallic iron in precipitating is considerable, and the amount of salt used and wasted is very large, being three tons or more for each ton of copper. The cost of salt in many copper-producing regions is very great, and the author described a new and more economical process contrived by himself and Mr. James Douglas, of Quebec, which is based on some little known reactions of copper and iron, which he had made known to the Association at a former meeting. When oxide of copper is brought in contact with protochloride of iron, this is decomposed, the iron being thrown down as peroxide, and the copper converted into a mixture of one-third soluble protochloride, and two-thirds of dichloride, insoluble in water, but soluble in a strong and hot brine. From this solution metallic iron throws down the whole of the copper or metal; regenerating the protochloride of iron, which is now ready to dissolve a fresh charge of oxide of copper, and so on indefinitely, using the same solution over again; the consumption of metallic iron being about two-thirds the weight of the iron. To prepare pyritous or sulphurous ores for this treatment, it is only necessary to calcine them at a low red heat. In this process the injurious elements of the ore, such as arsenic, antimony, and tin, remain undissolved, and the metallic copper obtained is so pure that it can be made into fine copper by a single fusion. If, however, silver be present, it is dissolved, and may be readily separated, so that this process is well adapted for silver-bearing copper ores, like many of those of the West.

The author described the works recently erected at the Ore Knob Mine, in North Carolina, where from 4,000 to 5,000 pounds of metallic copper are made daily by this process at a cost much below that at which it could be extracted by melting or any other process known, and stated that furnaces and tanks which will increase the production to four times that quantity are there in process of erection. Photographs of the present works and

specimens of copper obtained in a beautifully crystallized form by this process were exhibited. Copper deposits abound throughout the great Appalachian belt, from Newfoundland to Georgia. Some of these in the Blue Ridge are sources both of copper and sulphur, which latter would be employed to treat the phosphates of South Carolina, and fit them for use as fertilizers, while the copper would become, he predicted, an important article of export from these regions at no distant day. The copper of the mesozoic or new red sandstone formation of this country contains an abundance of this metal, often disseminated in such a manner that the ores could not be advantageously smelted, though he considered them well fitted for treatment by a wet process like that just noticed. Similar deposits are known to exist in the new red sandstone of the Connecticut Valley.

(144)

THE VOLCANIC REGION OF WESTERN SOUTH AMERICA.

BOUSSINGAULT gives botanical, meteorological, geological, and chemical details of a journey through the Cordilleras. The volcano of Puracé evolved carbon dioxide and hydrosulphuric acid. The large stream, called the Rio Vinagre, which rises in the neighborhood, has the following composition in 100,000 parts:

Sulphuric acid 34.75, hydrochloric acid 121.17, silica 2.37, alumina 40.28, lime 13.33, soda 12.32 = 324.22.

A torrent near Pasto was sufficiently acid to give off hydrogen from zinc. Near Ibagué, a deposit of sulphur was met with in the fissures of a mica-schist gorge. The mining galleries could not be pushed further than three metres, on account of the abundant evolution of carbon dioxide, which, acting on the skin, produced a sensation of suffocating heat, although the thermometer stood at 20° only. Near the Rio Guali, plain of Mariquita, a thermal spring was met with, having, in 100,000 parts, over 634 of sulphuric acid, besides other ingredients above named. In other localities sulphurous acid was evolved.

The hydrochloric acid is probably the result of the action of aqueous vapor and the silica of the trachyte upon chlorides, at a red heat. When sulphates are fused with silica at a white heat, oxygen is evolved, together with sulphur dioxide. This reaction probably occurs in the volcanoes. The sulphuric acid is the result of the action at 700°—900° of hydrochloric acid upon sulphates. The author describes experiments showing how complete this decomposition is: barium sulphate yielded 99.3 per cent of the calculated amount of barium chlo-

ride; strontium sulphate yielded 99.3, calcium sulphate 100.1, and sodium sulphate 96.6 per cent, the low result in the last case being due to the volatilization of the chloride. The sulphuric acid evolved from the calcium salt was 70 per cent of the quantity required by theory, and that from potassium sulphate was 92.2 per cent. Thus the vapor of this acid, so easily decomposed at the temperature employed, when pure, seems to resist decomposition when mixed with aqueous vapor and hydrochloric acid.

The warm spring of Cobalò, at the base of Puracé, has an alkaline reaction.

The common salt used in the provinces of Antioquia and Cauca is obtained by evaporating springs which flow from granite, gneiss, mica-schist, syenite, porphyry greenstone, and even from trachyte, instead of from the usual formations. The mother-liquor from the salt contains, for 100 of chlorine, 2. 3 of bromine and 0.07 of iodine.

PORCELAIN.

By H. Behrens.—Porcelain is generally regarded as the product of the partial fusion of its constituents, its opacity being due to unmelted particles of kaolin, the aggregates of which are rendered translucent by the glassy nature of other constituents which have undergone fusion, like paper soaked in varnish. According to this view, it would become transparent if exposed to a temperature sufficiently high to melt the kaolin. G. Rose, however, from experiments on the diminution of the density of porcelain when exposed to high temperatures, was led to believe that the kaolin does not remain unaltered in the fused materials, but enters, at least partially, into combination with felspar. The author finds that such is the fact. Microscopic examination of porcelain with sufficiently high powers shows that the kaolin has always undergone complete fusion, the only constituent of the porcelain which has partially retained the solid form being quartz. But the edges of the quartz particles are invariably rounded, and in certain kinds of hard porcelain no trace of quartz can be discovered, though such specimens exhibit in other respects precisely the same appearances under the microscope as porcelain containing unfused quartz.

Porcelain is one of the most difficult of microscopic objects, as regards both the preparation of specimens and their examination under the microscope. It must be ground to exceedingly thin plates, which require to be highly polished and examined with the very highest powers under the most favorable conditions of il-

lumination. The author employed an immersion-objective, magnifying 3,000 diameters. Under this power, porcelain exhibits an immense number of minute colorless crystalline rods (Zirkels *belonites*) with smooth edges, crossing each other in all directions. Between these are seen still smaller roundish granules, frequently so close together as completely to cover the glassy mass which forms the basis of the porcelain. One specimen (from the lid of a Berlin crucible) exhibited here and there bright spots containing neither belonites nor granules. Possibly in these places the fusion of quartz particles had rendered the glass uncrystallizable from excess of silica. Other specimens showed the quartz particles mentioned above. Besides these constituents, such specimens exhibit only minute air-bubbles, varying considerably in size and form. By treating thin plates of porcelain with dilute hydrofluoric acid, which dissolves the crystallized constituents much less rapidly than the quartz and glass, the author succeeded in obtaining specimens in which the dimensions of the belonites could be approximately measured, and their form and arrangement more clearly perceived. The belonites have sometimes rounded, sometimes obliquely truncated ends, in the latter case closely resembling microliths of felspar, but much smaller. Some have forked ends resembling hornblende microliths. Frequently the crystals are arranged side by side in bundles which cross each other in all directions, forming a network, in the meshes of which lie the granules mentioned above. Some of these granules are spherical, others are elongated; they occur both singly and in groups. They have the same diameter as the belonites, of which they might be regarded as fragments, were it not that they occur in natural and artificial devitrified masses in which no crystals are found. (88)

RECENT INVESTIGATIONS ON FERMENT SPORES.

By H. Hoffmann.—There are two views on this subject: 1st. That each particular ferment has its own particular seed; and, 2d. That one seed is common to all, or at least a large number of ferments, and that the particular ferment produced depends on the nature of the liquid on which the spore falls. The supporters of the former of these views are called *monomorphists*, and those of the latter *heteromorphists*. J. Duval has succeeded in producing a good wine containing 13 per cent alcohol, by employing cells of algæ (*Palmella cruenta*, *Protococcus viridus major*,

Hæmatococcus). No acetic acid was produced, and the form of the ferment was different from that of ordinary wine ferment.

Pasteur believes that the spoiling of beer (souring, putrefaction, ropiness), which is at present avoided by addition of hops, and keeping it in a cool cellar, is due to spores which are different from those of ordinary yeast, and produce the effects above mentioned in contact with air, or at a somewhat elevated temperature. It is therefore important to use the hopped beer under such conditions, that no such spores shall be introduced from the air.

On the other hand, yeast grows well with free access of air, but its morbid ferments grow little or not at all under such conditions. Pasteur therefore avails himself of this circumstance to obtain a pure yeast, and having done this, he prevents, as much as possible, the access of air. The fermentation then goes on slowly, but an excllent beer is produced. Pasteur has also shown that ripe plums, when kept in an atmosphere of carbonic acid, give off sugar, without changing their outward appearance, and the sugar ferments, yielding alcohol and carbonic acid. This does not happen in air.

Cienkowski has published an account of three bacteria greatly resembling each other, growing in sauerkraut and in various decomposing alcoholic liquids, and having each several different forms. He believes in the influence of the liquid in which the ferments fall, in determining to some extent the nature of the fermentation. Brefeld found that *Mucor racemosus, M. elegans* and *M. mucedo* may be changed into ordinary yeast by treatment with a suitable liquid. He also showed that ordinary yeast requires oxygen in order to grow, but not to produce fermentation, and that oxygen is absorbed in large quantity by it, a property not possessed by any other ferment except *mucor*. Trécul states that he has produced yeast from *Penicillium* and *vice versa*.

Kuiersim and Mayer have shown that acetic fermentation is not produced by allowing the wine to flow over clean beech-shavings. When in work the shavings are always covered with mycoderma, which can not be replaced by other bacteria. The temperature is much lower than that produced by the action of platinum-black on alcohol; and the by-products are different. A nitrogenous substance is necessary for the life of the mycoderma, and this can not well be replaced by nitrates. The most favorable temperature is 20° to 30°. The bacterium dies at 70°.

TECHNOLOGY.

IMPROVEMENT IN CHARCOAL FILTERS.

THE best and purest animal charcoal is ground and pulverized until it is brought into the finest possible state of comminution, and, thus prepared, it is mixed up with a definite proportion of Norway tar and a compound of other combustible ingredients. The combined materials are then thoroughly amalgamated with liquid pitch, and the whole kneaded up into a homogeneous plastic mass, which admits of being moulded into slabs or blocks of any required dimensions and shape. These blocks having been allowed to dry and harden, are subsequently carbonized by being subjected to a process of incineration by heat; and, in this manner, all the combustible ingredients are burnt out of the block, leaving nothing behind but the animal charcoal in the form of a block of charcoal, permeated throughout by innumerable pores, admirably adapted for the mechanical infiltration of fluids, while subjecting them, in a minutely subdivided state, to the chemical absorptive and purifying action of the carbon itself.

These carbon-blocks are chiefly cast in cylindrical forms, so arranged that the percolation is from the external periphery inward, and the centre of the block is hollow, forming a tube whence the filtered water flows. In this way the bulk of the impurities is deposited on the outside of the block, whence it may be removed by washing with hot water, or by scraping. Such filters, singly or in numbers, are placed in the bottom of a cistern, the central pipes of efflux being all connected together, and with one outlet. Where a large filtering capacity is required, a different principle is adopted, namely, a series of carbon-plates. In this case, the water, in its passage from the inlet to the outlet, is caused to pass through a number of frames, variously constructed, according to circumstances. Thus there may be, firstly, a frame, covered with fine wire gauze; then separate frames, paneled with carbon-plates, with or without the intervention of a bed of pure loose animal charcoal, filling up the spaces between them; and there may be also a double frame, containing a sheet of felt compressed between two perforated plates, made respectively of sheet-copper and zinc, which would exert a certain electrical action, and aid in the chemical action of precipitating impurities. The system may be used for filtering the water-supply of a town.

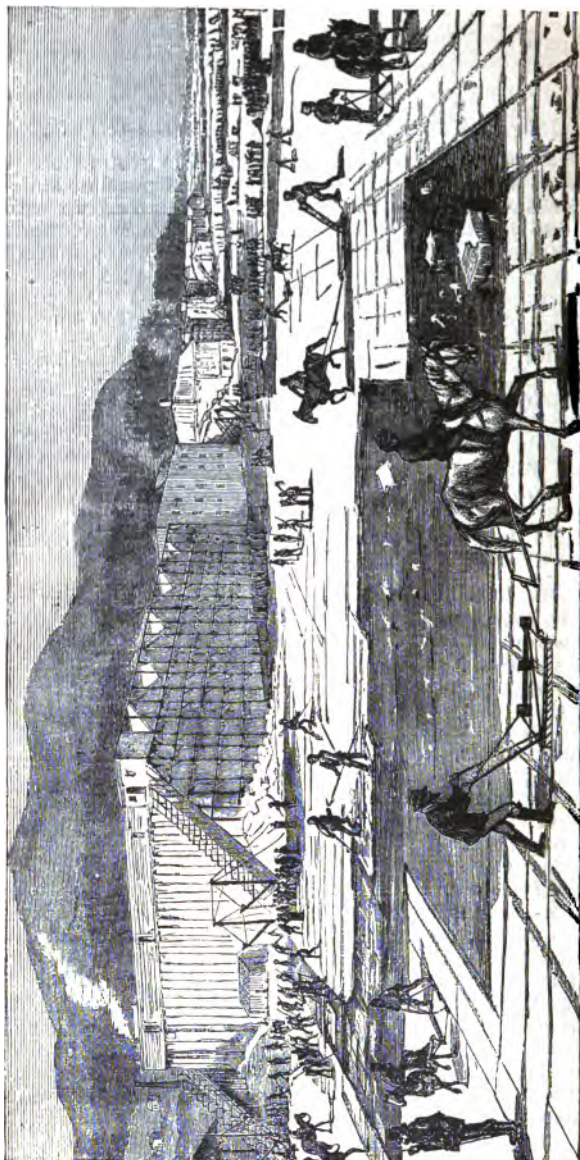


FIG. 1.—ICE-GATHERING ON THE HUDSON RIVER, NEAR NEW-YORK.

Apart from this hygienic use, these carbon-blocks may be employed for many industrial purposes. Experiments have shown them to be efficacious in removing deleterious gases, and other soluble substances held in solution in fluids. They are applied as filters for wines, oils, and syrups; and, above all, they merit attention as an adjunct to the feed-water apparatus of steam-boilers, inasmuch as efficient filtration affords the best, cheapest, and surest method for preventing incrustation in boilers. The invention is by Mr. Atkins. (106)

WATER-PROOFING COMPOUND.

THIS compound is prepared by melting paraffin and adding gradually a suitable drying oil, stirring well to insure intimate mixture; it is then poured into moulds the shape of bricks or blocks, and allowed to cool. The fabric to be rendered water-proof is rubbed over with a block of the compound, warming the rubbing face gently if the atmosphere is cold, and then ironing the cloth with a warm iron, or passing it between hot rollers. The application of this compound to leather and textile and felted fabrics is said to give excellent results, as, although it renders the cloth thoroughly water-proof, it is not impervious to air.

ADULTERATION OF INDIA-RUBBER.

THE *Bulletin Thérapeutique* says that, in order to use old and worn-out pieces of india-rubber scraps left from factories, manufacturers having easy consciences wash the material first in a solution of subcarbonate of soda or potash, and then, when dry, pulverize between cylinders. This powder, placed layer by layer between sheets of new rubber and heated to a certain degree, forms a homogeneous mass in which the fraud can not be detected. The mixture is, however, weak in tenacity and elasticity, and is unfit for surgical use, while dangerous for belting or other industrial employments.

MANUFACTURE AND GATHERING OF ICE.

OUR engravings illustrate the most recent improvements in the manufacture of ice by mechanism, and also the methods and tools employed for gathering and storing the natural article.

Fig. 1 is a general view from a winter scene on the Hudson river, one hundred miles above the city of New-York. At various convenient points along the banks of the river are located immense storehouses, within which the ice is deposited, and kept for summer use. Fifty thousand or a hundred thousand tons are frequently deposited

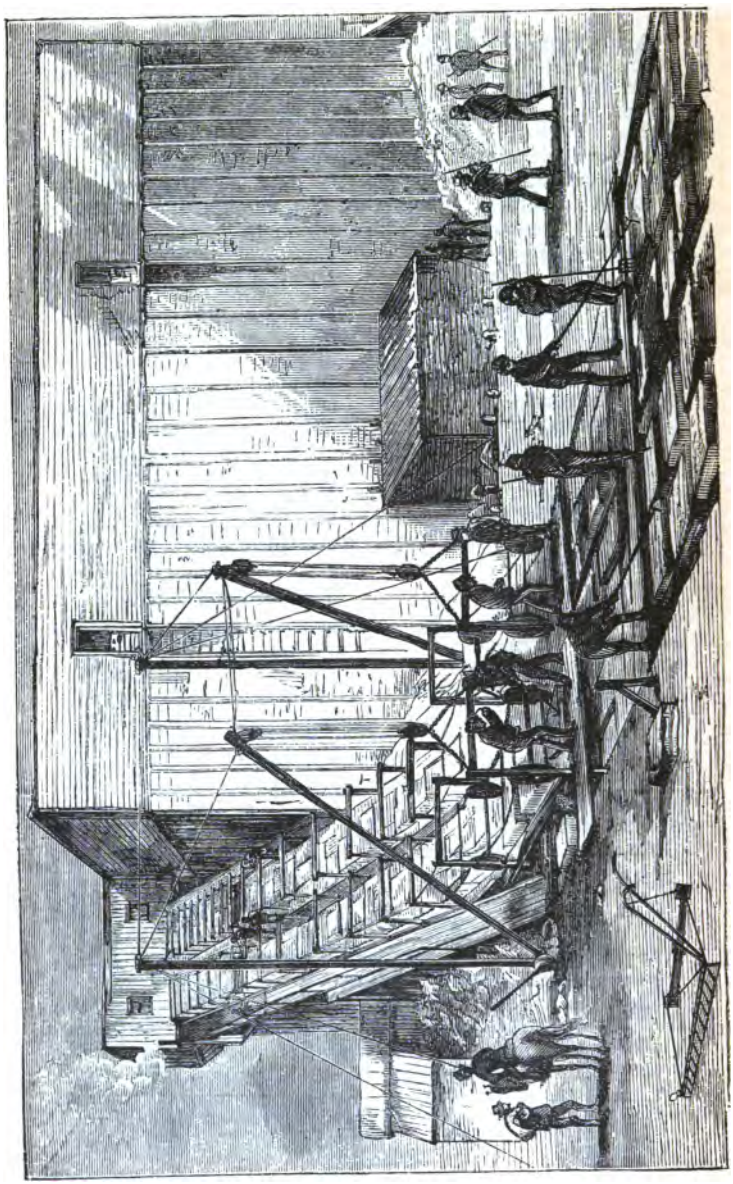


FIG. 2.—THE STEAM ICE-ELEVATOR.

in a single storehouse. The buildings are composed of wood, with double walls, and are very rough-looking. In summer the ice is loaded into barges, towed down stream to New-York, delivered therefrom directly into ice-carts at the dock, and thence distributed to customers at the

FIG. 2.—THE STEAM ICE-ELEVATOR.

doors of their dwellings. Ice is thus ordinarily supplied in New-York at a cost to the user of about ¼ of one cent up to one cent per pound, depending on the quantity taken and the relative abundance of the supply. An open winter yields a poor crop of ice, and the price during the ensuing summer is fixed at a higher figure.

In gathering ice, the work commences as soon as the ice

FIG. 3.—SMALL ICE-ELEVATOR.

reaches a thickness of nine inches. The plots of good ice (for the thickness and quality of the ice vary greatly at different points on the river) within convenient distance of the ice-houses are staked out and marked with hemlock brush. Then with ice-ploughs the men mark out the ice in suitable squares (36 by 22 inches), cutting the groove

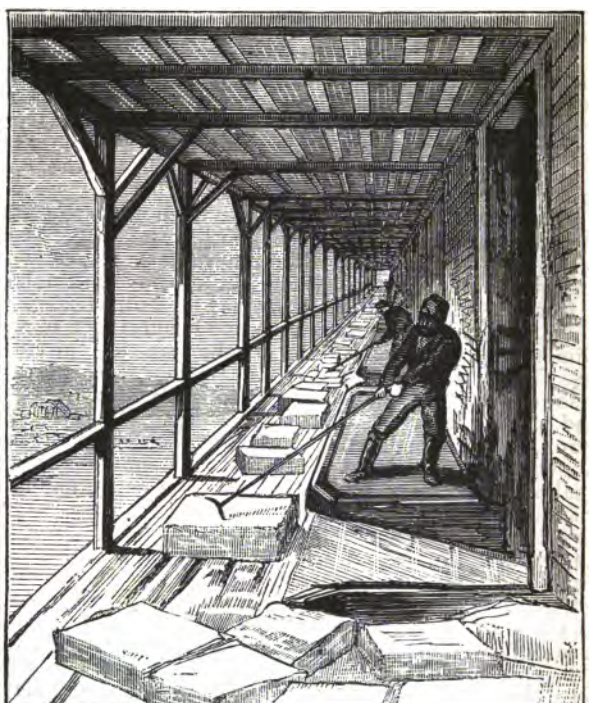


FIG. 4.—TRANSFER OF ICE FROM THE GALLERY TO THE STOREHOUSE.

about an inch in depth (see Fig. 1). Following the markers, ploughmen with ploughs of deeper blade sink the groove to a depth of three inches, and continue this operation until a sufficient depth is attained. Just enough ice is left to hold the blocks firmly together. The next operation is to separate a raft of the blocks (generally 112 in number) by taps of the heavy ice-chisel. These rafts are towed by

horses into a canal cut from the pond to the ice-house, where the raft is secured by pikemen, and thrust toward the slope of the ice-house. Before this is reached, men with tridents have broken the raft into single cakes, which, as they reach the slope, are guided to the cleets attached to endless chains, which, moved by steam-power, carry a steady stream of ice to any desired gallery of the storehouse (see Fig. 2). From this point, the blocks glide swiftly down an incline until they reach the doorways, where bar-men dexterously switch cake after cake into the slide which leads into the house. The work of stowing is quickly done, and the blocks are so arranged that a space of two or three inches between the cakes gives circulation of air and means of escape for the water from the melting ice. When the house is filled, loose hay is thrown over the top, and the house is closed.

The form of the ice-ploughs is shown in Figs. 1 and 2. One of the runners, which is smooth, rests on the ice and serves as a bearer ; the other runner is provided with a series of teeth or shares, which cut a groove in the ice.

In our northern latitudes, ice may be more cheaply supplied from natural sources than any other. But in warm climates, recourse is had to mechanism for producing ice. Fig. 5 illustrates one of the most recent machines made for the purpose, being the apparatus for making ice and producing cold, exhibited by Messrs. Vaas and Littmann, at the Vienna Exposition, in which, as in the well-known system of Carré, the vapor of ammonia is the congealing agent. The normal volatility of ammonia in both machines is increased by removing the vapor as quickly as it forms. The apparatus consists of the boiler, *a*, condenser, *b*, gasholder, *c*, ice-box, *d*, the absorption cylinder, *e*, the temperature exchanger, *f*, the cooler, *g*, and the pump, *h*. The boiler, *a*, is first half filled with solution of ammonia, which is caused to evaporate by the application of heat, and the gas thus formed is forced through the pipe, *i*, into the worm-pipe of the condenser, *b*, and from there through the pipe, 2, into the gasholder, *c*. From the gasholder, the gas is conducted by the pipe, 3, to the valve on the top of the ice-box, *d*, which is in connection with the worm-pipe inside the ice-box.

At the commencement of the operation this valve is kept shut ; but as soon as the gas has attained a pressure of eight to ten atmospheres, it is slightly opened. The gas, on its passage through the worm-pipes of the condenser (which are always surrounded by cold water), is condensed, and the liquid passes through the valve to the worm-pipes in the ice-box, where it again commences to

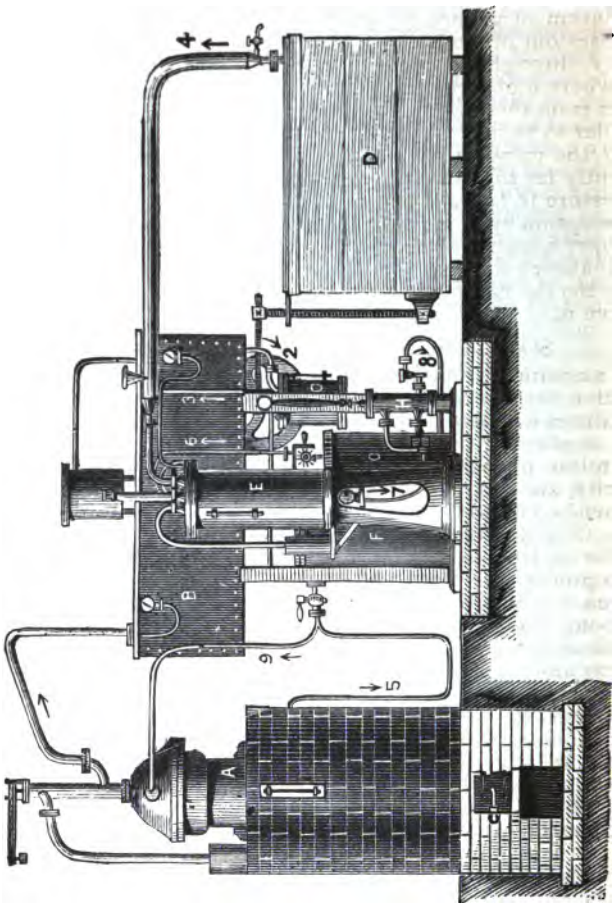


FIG. 5.—IMPROVED ICE-MAKING MACHINE.

evaporate, taking up at the same time heat from the solution of chloride of calcium, in which the worm-pipes in the ice-box are submerged. This absorption of heat so lowers the temperature of the solution of chloride of calcium as to render it capable of turning the fresh water contained in the ice-cases to ice.

The ammonia, which has been volatilized again in the pipes of the ice-box, passes through the pipes, 4, to the absorption cylinder, E, and, at the same time, the weak

solution of ammonia, which has lost the gas by heat, passes out of the boiler by the pipe, 5, into the exchanger, *f*, through the cooler, *g*, into the absorption cylinder, *e*, where it absorbs the gas which comes from the ice-box, and from these it is pumped back by the pump, 7, into the boiler to be again heated. When the machine is working, the valve on the ice-box must be opened just sufficiently far to allow the gas to escape, but not to allow the pressure to fall, and the valve between the cooler and the absorption cylinder must be so regulated as to admit the proper quantity of the weak solution from the boiler as will absorb the gas from the ice-box. A machine for making 200 lbs. of ice per hour requires a two-horse engine to drive it. (106—120)

SOME OF THE USES OF PARAFFIN.

IN addition to the properties which have brought it into such extensive use for illuminating purposes, paraffin has qualities which give it an exceedingly wide range of useful applications. White, clean, incorruptible, ordorless, tasteless, plastic, water-repellent, a non-conductor of electricity, and but slightly affected by most chemical agents, it needs only to be better known to become the most variously useful of the hydrocarbons.

For water-proofing fabrics for wearing apparel, military equipment, and the like, it is much better than rubber, since it is odorless and does not become sticky with heat. Among the most gratefully acknowledged of the many gifts sent out to Livingstone in the wilds of Africa, were boots and blankets thus prepared—the one enabling him to travel through mud, the other to sleep in it with comparative comfort. For the water-proofing of tent-cloths, ground-sheets for soldiers, and other articles of the sort, it has been found equally serviceable.

A more generally useful application of paraffin is for the lining of casks and other wooden vessels, to keep them sweet, and to prevent either the absorption of their contents by the wood or their escape through the pores. Already it has been largely applied to beer-barrels, wine-casks, and other vessels of the kind, with the happiest results. It keeps them from becoming musty and foul; and, still more, by filling the pores and joints of the staves it prevents the escape of the life of the liquor, carbonic acid gas. Water-buckets, butter-firkins, and other wooden articles of domestic use might be similarly treated; and as the material is cheap, easily obtained, and easily applied, it can be tried on as large or small a scale as one may feel disposed.

Being indifferent to most chemicals, paraffin serves the same purpose equally well in the laboratory of the che-

mist and chemical manufacturer. In the manufacture of gun-cotton, for example, wooden tanks lined with paraffin have been used for holding the mixture of concentrated sulphuric and nitric acids employed in that process, the protection of the wood being complete and lasting. Wooden boxes, protected in the same way, have been similarly employed in the construction of voltaic batteries. As a non-conductor of electricity, paraffin is further useful, as an insulator, for which it is now extensively employed in electric telegraphy; also in connection with batteries for medical use, especially as an acid-proof coating to insulated conducting wires. In surgery, it has been found an excellent material for covering for splints in cases of fracture.

Those troubled with loosely fitting plates of artificial teeth, owing to absorption of the gums, can easily remedy the defect by dropping upon the plate a little melted paraffin, from a lighted candle or otherwise, replacing the plate while the paraffin is yet warm. Being clean, tasteless, plastic at a low temperature, and unaffected by saliva, this substance will be found much superior to wax or any other material for the use, a few drops rightly placed making a perfect fit with a plate otherwise unwearable.

In the laundry, paraffin rubbed on the hot flat-iron imparts a beautiful gloss to starched goods, greatly lightens the labor of ironing, and leaves no greasy stain. For this use it is much superior to spermaceti. Friction-matches are now prepared with paraffin in place of the sulphur formerly employed; it burns without odor, and goes out instantly, greatly reducing the dangers of accidental fires. Dissolved in naphtha, paraffin has been applied with excellent effect to decaying brick and stone work, filling the pores of the brick or stone and putting a stop to the destructive action of the weather. Fine woodwork exposed to the elements might be protected in the same way. Heated with sulphur to a moderately high temperature, paraffin is decomposed, with the evolution of abundance of sulphuretted hydrogen. A steady and copious flow of this indispensable reagent in the laboratory is thus easily and cheaply obtained.

TRANSPARENT PARAFFIN.

THE paraffin of commerce is a colorless, translucent substance, perfectly inodorous and tasteless. It floats on water, and has a density of about 0.870, and melts at about 113° to 149° Fahr., forming a colorless oil, which, on cooling, again solidifies into a crystalline mass. It boils at about 698°, and volatilizes without decomposition. Pa-

raffin does not absorb oxygen from the air, and is only slowly attacked by sulphuric acid, even at the boiling point of water. It is not at all attacked by dilute nitric acid, and only by the strong acid after prolonged boiling. In fact, chlorine or any part of our most energetic chemicals but slowly acts upon this curious substance, which may be considered to be as neutral to the general run of chemicals as our glass vessels. Lately it has been discovered that if paraffin be heated for some considerable time in a tube sealed up, the result is a more fusible paraffin, exactly similar in its apparent chemical composition, but much more soft and fusible—that, in fact, if the heat be continued for a considerable time, the paraffin being still under pressure, we obtain ultimately a perfectly transparent liquid paraffin.

SPONTANEOUS COMBUSTION.

WE are inclined to believe, says *Engineering*, that one great cause of spontaneous combustion, in cotton and woolen mills, rests on the length of the fibre of the material left as oily waste. The finer this fibre, the greater is the danger of spontaneous combustion, and this becomes evident from the fact that in such cases the particles of the materials are in closer contact. In all our large docks of London, Liverpool, etc., thousands of tons of long stapled sheep's wool, imported from Australia, the Cape, and other places, full of animal oil, remain perfectly safe for years. In their transit, the bales containing such wool must have attained a temperature of at least 80° to 90°, yet we never hear of spontaneous combustion, either in the ships or the docks. But then comes the question of the character of the oil—as to whether the animal or the vegetable is the more dangerous. The late Dr. Graham considered that rags greased by butter heaped together would take fire within 24 hours. We question very much whether silk or sheep's wool is liable to spontaneous combustion, even in the presence of abundance of oil. Cotton, jute, all kinds of hemp and flax, mixed with oil, have an invariable tendency to spontaneous combustion at summer heat.

The only apparent remedy seems that of maintaining constant ventilation in all waste, etc., containing oil. Frequent turning is essential, and we have tried successfully the sprinkling of such waste with waste lyes or lime-water. It is remarkable that jute warehouses are peculiarly liable to catch fire; in fact, all members of the hemp and flax family are to be more feared than varieties of cotton.

IMPROVEMENT IN REFINING SUGAR.

A. H. WILLIAM SCHRADER, Hoboken, N. J.—Consists in subjecting raw sugar when suitably moistened to the action of a very high degree of pressure acting from above on its surface, so that the compressed air percolates between the granules of the sugar and effects the bleaching and purging of the sugar previous to its dissolution. The invention consists, further, in the dissolution of the sugar in the same tank under the admission of steam and water for the purpose of repeating and completing the purification, or drawing it off for passing through the filtering and discoloring operations to be returned and purged completely, and finally dried.

REFINING OF COTTON-SEED OIL.

ONE hundred gallons of the crude oil are placed in a tank, and 3 gallons of caustic potash lye, of 45° Baumé, are gradually added and well stirred for several hours; or the same quantity of oil is treated with about 6 gallons of soda lye of 25° or 30° Baumé, and heated for an hour or more to about 200° or 240° Fahr., under perpetual stirring, and left to settle. The clear yellow oil is then separated from the brown soap stock, and this dark soap sediment is placed into bags, where the remainder of the oil will drain off; and the sediment has a marketable value of 3 or 4 cents a pound for soap-makers. The potash lye has to be made in iron pots, but the oil and lye may be mixed in wooden tanks. (83)

A SUBSTITUTE FOR BRISTLES.

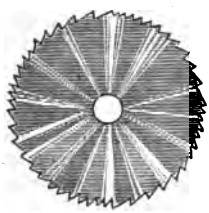
THE fibrous bark of the sugar palm (*arenga saccharia*) proves to be a good substitute for bristles and animal and human hair. The treatment is simple. The bark is first immersed in water and boiled for some time in an alkaline solution; the fibres are then soaked in an emulsion of fat, alkali, and water for about 12 hours, after which time they are sufficiently hard and elastic for the above-named use.

MANUFACTURE OF LAMP-BLACK.—J. H. Bottenberg, Ravenna, O., provides a revolving cylinder, which is kept cool. Within is a series of gas-jets, which deposit carbon on the interior of the cylinder, which carbon is removed by scrapers by the turning of the cylinder.

LEATHER PULP.—A process of pulping leather in engines, similar to those used for beating rags in a paper-mill, is now in use in Massachusetts. By rolling it into sheets under considerable pressure, a product of great tenacity, homogeneity, and closeness of texture is obtained, which is, moreover, perfectly water-proof.

IMPROVEMENT IN CIRCULAR SAWS.

E. ANDREWS, Williamsport, Pa., is the author of this improvement, which consists in arranging the teeth in groups, in which the first tooth shall be the longest, and the succeeding teeth shall gradually diminish in space to the last one in the group; but all the teeth, whether longer or shorter, have the same depth radially. The object is to make the saw cut with less applied power, or do more work with a given power. The saw is alleged to revolve with a series of reliefs from the usual constant resistance of the wood.



CONTRACTION OF TIRES.

M. L. MERLET proposes the following method of reducing the inner diameter of a tire which has been unduly enlarged by the hammer or the rolls so that it can not be put on when hot in the usual manner. The plan consists of heating it to redness, and then plunging it horizontally but only to half its breadth in water, and leaving it there till quite cold. The operation is then repeated in the same position, after which the tire is turned over, and the heatings and plungings applied to the other half of the ring. The first cooling produces a contraction of which the half not immersed partakes, and thus undergoes a molecular retraction resulting in a reduction of diameter; of course the same is produced in the other half during the second operation. In this way, a tire has been reduced 7 in 895. Four immersions instead of two will double the shrinking. In the same manner a ring of Bessemer steel, which had not only enlarged under the hammer but had also become conical in form in the interior, was brought to the exact diameter by means of heating and immersing thirteen times successively, first the side that was contracted, and afterward that which had become enlarged. In this case, the correction amounted to nearly four inches, but the diameter of the steel ring is not given.

A RECENT improvement in scissors consists in making the blades to fold at the pivot, like knife-blades. One blade may be opened, the other closed, and you have a penknife. Both blades open, and you have scissors. I. A. and R. W. Flack, patentees, New-York City.

POWDERED chalk, added to common glue, strengthens it. A glue which will resist the action of water is made by boiling one pound of glue in two quarts of milk.

TRANSPARENT FLUID COMPOUND FOR ENGRAVING PURPOSES.

FREDERICK DIFFANY, Newark, N. J.—This compound is used for engraving with the sand-blast when a large surface is required to be cut away, such as in bracelets, watch-cases, etc., for example. When it is desired to ornament a bracelet, the pattern is drawn with the compound, and such portions covered as may require to be left untouched by the action of acids or the sand-blast. The piece of metal thus prepared is set aside for a few hours until the compound stiffens, when it is ready to be treated with the sand-blast, which will rapidly cut away all such parts left uncovered. The compound is composed of benzine, ether, spirits of turpentine, india-rubber, shellac, dragon's-blood, mastic gum, and alkanet.

LINSEED-OIL.—Linseed-oil is obtained from flaxseed, by grinding the same under heavy stones, set on edge and made to revolve on beds of stone. Attached to the edge stone are scrapers which throw the seed into the circular track of the roller. The ground seed is placed in strong, woven woolen bags, which bags are covered with mats made of horse-hair and sole-leather, of a proper and sufficient width to protect the bags in the operation of pressing. These mats with their contents are subjected to an immense hydraulic pressure, and the expressed oil flows off into large iron tanks, where it is allowed to settle. What remains in the bags after the pressure is known as oil-cake. About 8,000,000 gallons of linseed-oil are used annually in the United States.

NEW HOT-WATER FUNNEL.—This consists of a tin funnel, with a perforated rubber stopper in the neck, through which the glass funnel is passed; the whole is covered with thick felt; the space between the glass and tin funnel is filled with hot water.

IN the manufacture of glass, by Hugh Percival, the glass-pots have openings below, and stand upon the bottom of the tank with the opening below the level of the molten glass, by means of which only refined glass enters the pot.

ALLOY FOR DENTAL PLATES.—Edward Conway, of Dayton, Ohio, makes a dental alloy as follows: Bismuth, tin, and lead are purified by separately melting and pouring upon clean marble slabs until all dross is removed, and afterward melting and pouring into lemon-juice. The alloy is composed of platinum, gold, silver, bismuth, tin, and lead.

IMPROVED ROTARY ENGINE.

EDWARD MYERS, New-York City.—The cylinder is provided with heads in the ordinary manner, and with a central partition. The shaft passes through the centres of the three heads. In the inner sides of the two outer heads, and in the opposite sides of the central head, are formed circular cavities, concentric with respect to each other, eccentric with respect to the heads, and tangent to the inner surface of the cylinder between the ports. Hollow drums are made to fit into the cavities and abut against the heads. In the ring ends of the drums, close to the circumference of said ends, and extended longitudinally through said shell, are formed round holes, in which are placed cylinders which are slotted longitudinally to receive the shanks of the pistons, which receive the shaft and carry the same with them in their revolution. The outer end of the pistons is made with flanges upon its opposite sides, fitting into a recess in the face of the drums, and its outer surface is curved to correspond with the inner surface of the cylinder. The steam chest has two branch ports leading into the cylinder upon the opposite sides of the central head. As the steam is admitted through one of the ports, it forces the piston around the inner surface of the cylinder, the steam in front of said piston all the time exhausting through the other port. The movement of the piston will rotate the shaft and drum about their separate axes. The eccentricity of the drum and shaft with respect to each other, and the location of the ports with respect to said axes, give space for the steam as it expands. To avoid this useless weight, the head of the piston may be made separate from its stem, and secured to it by screws, so that the head may be detached and the steam inserted and withdrawn through the interior of the drum; or a portion of one end of the drum, around the hole for the slotted cylinder, may be cut out and replaced by a piece secured by screws, so as to be readily detached and replaced. This allows the piston and cylinder to be removed together from the drum, the piston stem passing out edgewise.

CEMENT FOR MENDING STEAM-BOILERS.

MIX 2 parts of finely powdered litharge with 1 part of very fine sand, and one part of quicklime which has been allowed to slake spontaneously by exposure to the air. This mixture may be kept for any length of time without injuring. In using it, a portion is mixed into paste with linseed-oil, or, still better, boiled linseed-oil. In this state, it must be quickly applied, as it soon becomes hard.

INDIA-RUBBER FOR STEAM-PIPES.

As india-rubber plates and rings, says the *Journal of the Franklin Institute*, are now used almost exclusively for making connections between steam and other pipes and apparatus, much annoyance is often experienced by the impossibility of effecting an air-tight connection. This is obviated entirely by employing a cement which holds equally well to rubber and metal or wood. Such cement is prepared by a solution of shellac in ammonia. This is best made by soaking pulverized gum-shellac in ten times its weight of strong ammonia, when a shining mass is obtained, which, in three or four weeks, will become liquid, without the use of hot water. This softens the rubber, and becomes, after volatilization of the ammonia, hard and impermeable to gases and fluids.

ISOLATING MATERIAL FOR STEAM-PIPES.—The committee for the trial and inspection of boilers of the State of Saxe-Anhalt, Germany, recommend the following composition for the above purpose: 132 lbs. limestone, 385 lbs. coal, 275 lbs. clay, and 330 lbs. sifted coal-ashes. This is finely pulverized and mixed with 660 lbs. of water, 11 lbs. sulphuric acid at 50° B., and 160 lbs. of calves' hair or hog bristles. The compound is applied to the pipes in coats of 0.4 inch thickness, repeated until a thickness of an inch and a half is obtained, when a light covering of oil is given.

NEW FIRE-GRATE.

A FORM of grate has been lately patented, to which is attached a feeder for supplying the fuel from below. It is said that more heat is utilized by keeping the hottest fire at the top, thus also preserving the bars from being burned out; coal is saved, because it ignites more gradually, and leaves after burning no residue except a fine powdery ash, which falls without raking; no cold air is admitted in feeding, and the heat is uniform.

CEMENTS FOR AQUARIUMS.—1st, melt together 2 parts common pitch, with 1 of gutta-percha. Incorporate well. To be poured while soft (but not too hot) into the joints. It can also be applied with a hot iron, in the same manner as solder. 2d. Zinc-white 2 parts, copal varnish 1 part. 3d. Common resin 8 parts, calcined plaster 1 part. Melt and incorporate. Add boiled oil 1 part. Apply warm.

To blacken the insides of tubes for optical instruments, opticians use a mixture of vegetable black, alcohol, and shellac.

METHOD OF TESTING METALS.

THE method is, in general, as follows: Cut, from the bar or mass to be tested, pieces about three and a half or four inches long, and turn them off in the middle to a diameter of half an inch for iron or brass and three eighths if of steel; make this neck one inch long. A square head is left at each end. Secure the piece vertically and firmly by one end, in a strong vise; fit a solid-ended wrench to the other end of the test piece; and to the extremity of the handle, which should be, for convenience, about five feet long, attach a spring balance capable of recording with accuracy up to fifty or sixty pounds.

Paint the scale of the balance with white lead or tallow, and spring the pointer so as to just touch the painted surface. The mark traced by the pointer then indicates the maximum force applied.

Commence pulling steadily on the balance, keeping the direction of pull at right angles to the wrench-handle.

An apparently unyielding resistance will be felt up to a certain point, when the test piece will commence observably to give way. Note the indication of the spring-balance at this point, which is the *limit of elasticity*, and record both that reading and, if possible, the distance through which the piece has twisted, the latter measure being an indication of its stiffness.

Continue twisting the piece until it has gone some distance beyond the limit of its elasticity, then stop and notice how far the arm springs back while gradually taking off the twisting force.

This distance is a measure of the *elasticity* of the metal, and is usually, if not invariably, the same, however great the set, even up to the point of rupture.

Renew the twisting force and break off the piece, noting the maximum angle which the piece has been twisted through and the maximum resistance, as indicated by the spring balance.

The *stiffness* of the metal is measured by the force required to twist it through the first small angle, say five degrees, should it yield so far without set. For half-inch iron, this should be about fifty pounds on the end of a lever five feet long. For tool steel, it should be about thirty pounds, where the neck has a diameter of three eighths inch.

The *limit of elasticity* is determined by the force required to give it its earliest set.

The *degree of elasticity* is measured by the distance through which the wrench springs back when the force is removed after producing set.

The *ultimate tensile strength* is approximately proportioned to the force producing *rupture* by torsion.

The *limit of elasticity for tensile strength* is proportional to the force producing *set* by torsion.

The *ductility* of the metal is measured by the *angle* through which the piece twists before breaking.

The power of resisting shock, or *resilience*, as it is called by engineers, is nearly proportioned to the product obtained by multiplying the breaking force by the maximum angle of torsion.

The *homogeneity* of the metal is determined by the regularity with which the resistance of the piece increases when passing its limit of elasticity.

By taking samples of well-known brands of metals and pursuing this course, a standard is easily obtained, by reference to which a little practice will enable the experimenter to learn readily, and pretty accurately, the relative value of such other metals as he wishes to test.

Next, taking the fractured pieces, a careful inspection will assist wonderfully in pronouncing a correct judgment.

METAL ORNAMENTATION.

MR. W. C. AITKEN, in a paper read before the British Society of Arts, gives the following interesting details regarding some ornamental processes connected with metallic industries: Enamel is simply glass, composed of lead and sand. When transparent, oxide of tin renders the transparent glass opaque; mixed with oxide of gold, it changes the clear or opaque glass into a purple; red is produced by the addition of sulphate of iron; oxide of copper produces green, violet is produced by manganese, blue by oxide of cobalt.

The enamel is poured from the crucible in which it is melted into flat cakes; these cakes are broken up and reduced to a fine granular condition in a mortar, or to an impalpable powder by grinding with a muller on a slab; it is applied on metal which will stand a red heat without changing its form or fusing. Gold, silver, copper, brass, or iron can be enameled. There is no true enamel which has not been fused at a red heat. The modes of application vary; applied on a flat plate or plaque, it is worked with a brush. Of this class are the Limoges enamels. Other methods of application consist in incising or cutting small troughs in the surface of the metallic object intended to be enameled. In these the enamel is placed or applied; this method of application is called the *champlevé*. Another method of reproducing is by means of electro-deposition.

The next variety of enamels is the partitioned or *cloisonné;* in this variety the cells are formed by bending a flat narrow strip of metal in such a manner as to form the retaining walls. These, after being prepared, are arranged on the object and soldered to it. The various colors of enamel are then applied in the cells, and fired by subjecting the object to be enameled to the heat of a muffle. Repeated applications of enamel with repeated firings are required to fill the cells. The superfluous enamel is finally removed by grinding it away with pumice-stone, and smoothing it with stones of different degrees of fineness. Apart from the labor of forming and placing the minute cells, there are difficulties attending the firing operation. Should one part of the muffle be too hot, and the solder become melted which holds the cells, the more the enamel is in a fluid condition, the colors mingle, and a confluent mixture of colors is the result.

Niello may be called a metallic enamel composed of silver, copper, lead, and sulphur; in its preparation the most difficult metal to fuse is first melted, the next fusible added, and so on; the melted metals in the crucible are stirred with stick charcoal to insure homogeneity; the result is a black compound, which, poured from the crucible, is beaten into strips. The design to which it is applied is engraved on the metal object to be decorated, the lines being more pronounced and stronger than on an ordinary copper plate for printing from. The mode of applying the niello is by heating the object and rubbing the niello into the lines; when skillfully applied, the niello adheres firmly; excess of it is removed by files, the surface is then stoned, and finally polished. Niello is undoubtedly by far the best means for decorating in a quiet, rich manner surfaces exposed to friction or wear; it is tougher than enamel.

Damascening, or inlaying one metal in another, is an art which has been practiced for a very long period, introduced chiefly on armor and caskets, etc. There are two methods of practicing the process. By one method the surface of the metal to be damascened is raised up into a file-like surface; the artist, by his skill, causes to adhere, to the roughened surface, threads of gold or silver, which are applied and burnished down. Broad surfaces are produced by working the threads or wires side by side. Heat is applied; the degree necessary requires great judgment. In the other, the surface to be damascened is incised or cut into, the incision at the bottom being expanded; into this channel gold or silver is introduced and beaten down.

SURFACING SHEET-IRON TO RESEMBLE RUSSIA IRON.

JOHN STACKHOUSE, Allegheny, Pa.—The sheets of ordinary iron of good quality are placed in packs of four sheets, and immersed in a solution of oxalic acid and water. When the iron is heated, the water evaporates, leaving a slight film on the surface of each sheet of iron, which is converted into carbonic acid gas. This gas combines with the iron, and hardens the surface. The surface of the iron is, consequently, left clean, and takes a high polish when sheets are rolled, the iron resembling the best quality of Russia sheet-iron.

THE WELDING OF IRON.

WHEN two pieces of ice are rubbed against each other, fusion takes place between the surfaces of contact, at a temperature below zero. As soon as the pressure ceases, solidification is again produced and the pieces are welded together.

It seems to me that the welding of iron is a phenomenon exactly similar. The two pieces of iron are brought to a white heat—that is to say, more or less near to the fusing point. The repeated blows of the hammer, or the pressure of the rolls, lowers the point of fusion and causes a superficial liquefaction of the parts in contact, and thus welds the masses together; and this, because, like water, iron dilates in passing from the liquid to the solid state. Many other metals are similarly endowed; they all therefore may be welded like iron, if other conditions do not come in to oppose the manifestation of this property. Platinum welds easily at a white heat, because its non-oxidizable surface, like that of ice, takes on a superficial fusion. To weld iron successfully, it is necessary that its surface should be clean—that is, free from oxide. Iron containing phosphorus welds more easily than pure iron, because its point of fusion is lower. Steel, which is more fusible still, welds at a lower temperature than iron, but the process is a more delicate one. Silver, too, like iron and platinum, has the property of expanding when it solidifies; but as it melts at a cherry-red heat, it is easier to form it by casting than by welding. Bismuth and zinc are always included in the same class; but they are so very brittle near their fusing points that no one would think of attempting to weld them either by hammering or pressure. Iron in welding, therefore, only follows the example of water.

The fibrous state of iron is not a normal and regular one. All crystalline iron, if the crystals are not too hard,

breaks with a fibrous structure, if time be given, in the breaking, for these crystals to be drawn out into fibres. Iron which is fibrous is only iron in which the primitive crystals, surrounded by very thin films of slag—and thus separated from each other—have not been welded together during the rolling, but have been elongated into wires. A bar of such iron resembles a bundle of wires in its resistance to traction, but it breaks with a granular fracture when exposed to a transverse blow, suddenly applied.—*M. Jordan.*

NICKELING.

By S. P. Sharples, Massachusetts State Assayer.—The double sulphate of nickel and ammonia, which is the salt that is generally used, may now be had in commerce almost pure. It is manufactured on a large scale by Joseph Wharton, of Camden, N. J., who controls the nickel market in this country. Cast nickel plates for anodes may be obtained from the same source. The anodes should considerably exceed in size the articles to be covered with nickel. Any common form of battery may be used. Three Daniell's or Smee's cells, or two Bunsen's, connected for intensity, will be found to be sufficient. The battery-power must not be too strong, or the deposited nickel will be black. A strong solution of the sulphate is made and placed in any suitable vessel; a glazed stoneware pot answers very well if the articles to be covered are small. Across the top of this are placed two heavy copper wires, to one of which the articles to be covered are suspended, to the other the anode. The wire leading from the zinc of the battery must then be connected with the wire from which the articles are suspended, the other battery-wire being connected with the anode.

In order to prepare the articles for coating, they must be well cleaned by first scrubbing them with caustic soda or potash, to remove any grease, and then dipping them for an instant in *aqua regia*, and afterward washing thoroughly with water, taking care that the hand does not come in contact with any part of them. This is accomplished by fastening a flexible copper wire around them, and handling them by means of it. The wire serves afterward to suspend them in the bath.

If the articles are made of iron or steel, they must be first covered with a thin coat of copper. This is best done by the cyanide bath, which is prepared by dissolving precipitated oxide of copper in cyanide of potassium. A copper plate is used as an anode. After they are removed from the copper bath, they must be washed quickly

with water and placed in the nickel bath; if allowed to dry or become tarnished, the nickel will not adhere.

Great care must be used through the whole process to keep all grease, dust, or other dirt from the articles to be covered, or else the result will be unsatisfactory. The whole process is one of the most difficult that is used in the arts, it being far easier to gild, plate, or copper an article than to nickel it; but if due care be taken, the results will amply pay for the trouble. (69)

NEW IMITATION OF SILVER.

A PATENT has been obtained by M. Pirsch-Baudvin for a metallic alloy which is declared to resemble silver better than any other yet known with respect to color, specific gravity, malleability, ductility, sound, and other characteristics. The new alloy is a compound of copper, nickel, tin, zinc, cobalt, and iron. The following proportions are said to produce a very white metal, perfectly imitating silver: Copper, 71.00 parts; nickel, 16.50 parts; cobalt, 1.75 parts; tin, 2.50 parts; iron, 1.25 parts; zinc, 7.00 parts. A small quantity of aluminum, about 1½ per cent, may be added. The manufacture is rather peculiar. The first step is to alloy the nickel with its own weight of the copper and the zinc in the proportion of six parts to ten of copper. The nickel alloy, the iron, the rest of the copper, the cobalt, in the form of black oxide, and charcoal are then placed all together in a plumbago crucible. This is then covered over with charcoal and exposed to great heat. When the whole is melted, the heat is allowed to subside, and the alloy of zinc and copper is added when the temperature is just sufficient to melt it. This done, the crucible is taken off the fire and its contents stirred with a hazel stick; the tin is then added, first being wrapped in paper and then dropped into the crucible. The alloy is again stirred, and finally poured into the moulds; it is now ready to be rolled and wrought just like silver. A great portion of the zinc is volatilized in the act of fusion, so that a very little remains in the alloy. The superiority of this metal is said to depend principally on the cobalt, to which is due its peculiar argentine lustre.

NEW METHOD OF COLORING METALS.

METALS may be colored quickly and cheaply by forming on their surface a coating of a thin film of a sulphide. In five minutes, brass articles may be coated with any color, varying from gold to copper red, then to carmine, dark red, and from light aniline blue to a blue white, like sulphide of lead, and at last a reddish white, according to

the thickness of the coat, which depends on the length of time the metal remains in the solution used. The colors possess a very good lustre; and if the articles to be colored have been previously thoroughly cleaned by means of acids and alkalies, they adhere so firmly that they may be operated upon by the polishing steel.

To prepare the solution, dissolve 1½ ounces of hyposulphite of soda in 1 pound of water, and add 1½ ounces of acetate of lead dissolved in ½ pound of water. When this clear solution is heated to from 190° to 210° Fahr., it decomposes slowly and precipitates sulphide of lead in brown flakes. If metal be now present, a part of the sulphide of lead is deposited thereon, and, according to the thickness of the deposited sulphide of lead, the above colors are produced. To produce an even coloring, the articles must be evenly heated. Iron treated with this solution takes a steel-blue color; zinc, a brown color; in the case of copper objects, the first gold color does not appear; lead and zinc are entirely indifferent.

If, instead of the acetate of lead, an equal weight of sulphuric acid is added to the hyposulphite of soda, and the process carried on as before, the brass is covered with a very beautiful red, which is followed by a green (which is not in the first mentioned scale of colors), and changes finally to a splendid brown with green and red iris glitter. This last is a very durable coating, and may find special attention in manufactures, especially as some of the others are not very permanent.

Very beautiful marble designs can be produced by using a lead solution, thickened with gum tragacanth, on brass which has been heated to 210° Fahr., and is afterward treated by the usual solution of sulphide of lead. The solution may be used several times.

ELECTROPLATING PEWTER SURFACES.

TAKE 1 ounce nitric acid, and drop pieces of copper in it until effervescence ceases; then add ½ ounce water, and the solution is ready for use. Place a few drops of the solution on the desired surface, and touch it with a piece of steel, and there will be a beautiful film of copper deposited. The application may be repeated if necessary, though once is generally sufficient. The article must now be washed and immediately be placed in the plating-bath, when deposition will take place with perfect ease. (83)

TO GIVE IRON A TEMPER FOR CUTTING PORPHYRY.—Make your iron red-hot, and plunge it into water distilled from nettles, acanthus, and pilosella, or else in the juice pounded out from these plants.

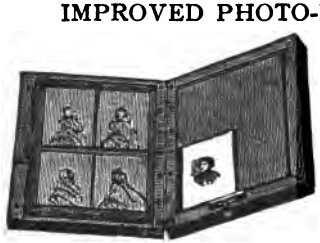
NON-CORROSIVE PIPES AND PLATES.

A RECENT patent by W. A. Shaw, of New-York City, has for its object to protect tubes or metal plates from corrosion by associating with them other metals or alloys, the presence of which renders the entire combination passive. It is known that the presence of platinum protects iron from corrosion, and that zinc will partially protect iron and copper. An instance of the last-named fact is the well-known application, by Sir Humphry Davy, in sheathing vessels.

One method of carrying out the present invention is to make a pipe or tube of any one or more of the ductile metals, by drawing, rolling, or by pressing said metals out of a cylinder through a die. At the same time this operation is being performed, a ribbon, band, or wire of a protecting metal or metals is drawn through the die with the tube under treatment, emerging therewith, either wholly or partially inlaid within the inside surface of the tube. One or more such bands may thus be inlaid, and they may be alike or of different metals. The inlaid bands may be imbedded in the shell of the pipe, so as to be flush with the surface thereof, or they may be allowed to project, so as to present a greater amount of protecting surface.

It is alleged by the inventor that, when strips of lead and tin are simultaneously exposed to the action of water, the presence of the tin effectually protects the lead from corrosion, and that there is practically no corrosive action upon these metals when associated in this manner.

IMPROVED PHOTO-PRINTING FRAME.



THIS is an elastic frame specially adapted for the printing of positives on opal glass. This frame, owing to its construction, allows the following of the progress of the impression without disturbing the negative, which is kept in its frame against the plate by means of a spring; on the other hand, when it is desirable not to cut a negative on which are several images, a piece of sheet-iron, rather thinner than the opal glass, is fitted to the frame. Of this plate, a corner is removed of the size of the positive print, which is thus rigidly held by the spring shown in the figure. The lower part of this frame being elastic, the image is always in per-

fect contact with the negative by the pressure of the spring.

The contact should be very rigid to obtain the half-tones; because, besides losing a great deal of its intensity in the toning and fixing baths, the image seen by transparency through the opaline medium never has the same vigor as when seen directly by reflection.

TRANSPARENT PHOTOGRAPHS.

A LAUNDRESS'S flat-iron is, perhaps, the most convenient thing that can be made available for mounting the print upon the glass—using a piece of bibulous paper between the iron and the print to absorb the superfluous paraffin. Such a mounting may be very usefully employed for securing the soft effect produced by placing a second picture behind the transparency.

In this method of manipulating, it will be necessary to melt the paraffin, and perhaps the following mixture may be utilized with advantage, as it is fluid at ordinary temperatures, or, if not so, the warmth of the hand will render it liquid. The small quantity of Canadian balsam is introduced for the purpose of making the print more adhesive to the glass; but we really have grave doubts as to its proving of any great advantage in practice, because even this substance is, to a certain extent, amenable to the action of the light and oxygen: Paraffin, 2 drachms; benzole, 5 fluidrachms,; Canadian balsam, half a fluidrachm.

The paraffin should be melted, removed some distance from the light, and four fluidrachms of the benzole added during agitation. The Canadian balsam is to be dissolved in the other drachm of benzole, and the whole is then to be mixed together. Paraffin and Canadian balsam do not mix very well; but with interposition of the menstruum, benzole, they seem to blend perfectly.

The advantages of such a mixture as the above are that it can be applied cold with a brush, and that it drys perfectly in a very short time if the benzole be of good quality. To perfect the adhesion, however, we would recommend that the warm iron should be passed over the surface after it is quite dry. Such an operation also insures the volatilization of any traces of the benzole that might remain. The same solution might, perhaps, be used with advantage to preserve prints from atmospheric influence.

(1)

AN adhesive cement for aquaria may be made, according to Klein, by mixing equal parts of flowers of sulphur, pulverized sal-ammoniac, and iron-filings, with good linseed-oil varnish, and then adding enough of pure white-lead to form a firm, easily worked mass.

THE TRANSFER OF VARNISHED NEGATIVE FILMS.

FOR the purpose of peeling off the film from a varnished negative, I prepare, in the first place, a mixture composed of the under-mentioned materials, namely:

Gelatin	60 parts.
Acetic acid	90 "
Water	180 "
Ordinary soap	½ part.

The above ingredients are mixed together, and then poured rapidly over the varnished film in such a way that every part of the surface is uniformly covered, and no portion treated a second time. The superfluous liquid is poured off and thrown away, for it can not be employed again for the same purpose.

The film is then allowed to dry, and, when perfectly desiccated, some thick normal collodion is poured over it, to which a little castor-oil has been added. This leather collodion, having dried uniformly over the negative film, will be found capable of being peeled off, bringing the collodion image with it.

Should the film, when separated from the glass, lack thickness, and it is desired to secure the *cliché* film of a stouter and more compact nature, the same may be treated with a solution of gelatin (without soap) after the leather collodion has been applied, and even with a second application of collodion if such is deemed necessary.

By employing this plan of proceeding, I may mention that I have stripped upward of a hundred negative films from glass, all of which had been previously varnished, without having had a single mishap. They were from plates prepared by the ordinary wet collodion process; but whether dry plates (and especially those which have been prepared with a substratum of albumen) could be so readily treated, is a matter of which I have no experience at present. (21)

NEW DISCOVERY IN PHOTOGRAPHY.

DR. HERMAN VOGEL has discovered that if dry bromide plates are colored or dyed, their photographic sensitiveness in respect to certain colors is greatly increased. The use of aniline dyes is found especially advantageous. For example, a plate dyed with aniline green absorbs red rays, and is made very sensitive to red colors, the photography of which has heretofore been almost impossible. It is expected that valuable practical results will ensue from this new discovery.

PHOTOGRAPHIC ENGRAVING.

THE subjects suitable for printing-blocks, of the kind now to be described, are those known as line and dot subjects—that is, pen and ink sketches, line drawings, engravings, and such like, to the exclusion of objects in pure graduated tint, like a silver print from a negative of a natural subject having graduation of tint.

A plate of glass is coated with a solution of beeswax in ether, the relative proportions of the two being about half an ounce of wax to ten of ether. This leaves a very thin coating of wax upon the plate, which is still further attenuated by rubbing with a cloth. The object of this waxing is to prevent a too close adhesion of the gelatin coating, to be next applied.

To prepare the sensitive surface, gelatin is steeped in water for half an hour or upward until it has become swollen from the absorption of water; most of the superfluous or unabsorbed water is now poured off, and the vessel containing the gelatin is placed in hot water, or otherwise subjected to heat, by which the gelatin immediately becomes liquefied. To this is added sufficient of a saturated solution of bichromate of potash to render it of an orange color, yet not sufficient to cause the salt to crystallize out and show itself upon the surface of a glass plate coated with the mixture. The film is dried and then removed from the glass, which is permitted to be done by the agency of the wax substratum. It is now ready for exposure.

Suppose, now, that a reproduction of an engraving or piece of ordinary print or sheet of music be the subject that is to be produced; a transparency—not a negative—of this subject must have been obtained and superimposed upon the side of the gelatin pellicle next to the glass plate. After exposure to light for a quarter of an hour—or more or less, according to the light and the quality of the negative—this gelatin film is pressed into contact with any handy flat surface, such as glass or metal, care being taken that the surface that was next the negative be placed outside. It is now sponged copiously with, or immersed in, cold water, by which a considerable amount of relief is obtained, the parts corresponding with the black of the original print or drawing being seen standing in high relief, while the whites are sunk. This, it will be seen, supplies the conditions for a surface block to print in connection with type, all that is now wanted being the conversion of the soft gelatin into hard, unyielding metal.

The gelatin relief or mould obtained in the manner described is, first of all, made surface-dry by means of bibu-

lous paper, and is then lightly dusted over with finely pulverized plumbago or bronze-powder. A cast from this surface is then taken by means of molten beeswax, which, when cold, readily parts company with the gelatin relief, owing to the intervening sprinkling of plumbago or bronze. This wax cast is then sent to the electrotyper, who, in a few hours afterward, will deliver a metallic cast, mounted upon wood and ready for working in the printing-press. This process originated with Mr. Thomas West, of London. (1)

PHOTOGRAPHIC PRINTS IN PLATINUM.

WILLIS, JR.—The paper is floated on a solution of 1 part potassio-platinic chloride in 48 parts water, dried, saturated with plumbic nitrate solution, 1 to 12, dried a second time, and then painted with a solution of ferric oxalate, 1 to 8, to which a little oxalic acid has been added to render the iron salt soluble. When dry, the paper is exposed under a negative, and the weak brown picture produced floated on a hot solution of potassic oxalate, which develops it to a deep black. It is then washed in a dilute solution of oxalic acid, next in "hypo" bath, and lastly in water. Argentic nitrate may be substituted for the lead salt, or platinic bromide with ferric tartrate for the potassio-platinic chloride.

IMPROVEMENT IN TREATING PHOTO-NEGATIVES.

WHEN, by means of a camel's-hair brush or otherwise, iodine is applied to the image, the atoms of metallic silver which formed the picture are acted upon by the iodine, and are converted into iodide of silver. Now, as metallic silver is not soluble in a weak solution of cyanide of potassium, but as iodide of silver is soluble, it follows that the application of this menstruum will instantly convert into clear glass every portion of a negative that has been touched by the tincture of iodine. Its use, then, will be obvious. Every thing in a negative not desirable to be retained can be completely removed—a tree, a house, a background, a restless baby, or any other objectionable member of a group.

Iodine dissolves freely in alcohol, ether, chloroform, sulphide of carbon, petroleum, and in solutions of the iodides. It is the latter of these that we recommend as a solvent when the solution is to be employed in acting upon a negative. Drop a crystal of iodine into a little water, and no visible change takes place, the water remaining clear as before; but on adding a crystal of iodide

of potassium, it will be found that, as soon as the latter has reached the bottom of the vessel, the iodine immediately becomes affected and dissolves readily, and the solution becomes of an intensely deep red color.

We find that if the iodine solution be thickened by the addition of a small quantity of mucilage of gum arabic, say a little more in proportion than is contained in common writing-ink, all tendency to spread is destroyed. The solution may be applied by means of a delicate hair-pencil, and in the most minute specks, lines, or stipples; and, after the clearing up application of the cyanide, these specks and touches will be found to be clear and sharply defined, showing that no extension has taken place. (1)

REPRODUCTION OF PHOTO-NEGATIVES.

THE sensitive compound I have hitherto employed for coating the plates is made up of dextrine, 4 grammes; ordinary white sugar, 5 grammes; bichromate of ammonia, 2 grammes; water, 100 grammes; glycerine, according to the condition of the atmosphere, 2 to 8 drops.

A new, well-cleaned, patent plate is coated with the sensitive chromium solution; and after the superfluous liquid has been allowed to flow off at one of the corners, the plate is dried in the dark by being placed upon a lithographic stone or metal plate, a period of ten minutes being sufficient for the purpose, with a temperature of 120° to 160° Fahr.

The film being perfectly dry, the plate, still warm, is put under a negative and printed in the shade for ten or fifteen minutes. As soon as it comes out of the printing-frame, the plate is again slightly warmed; the brush is dipped into the graphite and applied over the surface of the image, which should be just slightly visible. The application of the powder is carried on in a shaded corner of an ordinary room illuminated by daylight. You must not press hardly upon the film with the brush, but move the same over the surface as lightly as possible; nor will it do to hurry the operation.

In proportion as the film cools so the image appears. By carefully breathing or, better still, blowing upon the film, you will be able to accelerate the process, and when the picture has attained sufficient vigor, you take off the superfluous graphite powder with a clean brush.

A normal collodion is now applied; such as I use is composed of alcohol, 500 parts; ether, 500 parts; pyroxyline, 15 to 20 parts.

When this film has set and hardened, the margins are cut round with a knife, and the plate put into a porcelain

dish of cold water. In three minutes the picture will be free from the glass, and the film may be employed in this position or reversed with a soft brush, and taken out of the water adhering either to the same glass plate or to another. A gentle stream of water falling upon the film will remove any chromium salts still remaining in it, and will also press down the loose film uniformly upon the glass surface. Finally, the plate is allowed to dry in a perpendicular position. Further treatment of the plate with varnish follows as a matter of course.

The image upon the collodion film is very thin; but you need be under no apprehension of its tearing while in the water, when it may be easily manipulated. I have to do with films of this kind measuring three feet square.—*J. B. Obernetter.*

NEW PHOTOGRAPHIC PROCESS.

A RECENT improvement in dry-plate photography which consists in using gelatin instead of the ordinary collodion. The nitrate of silver, for sensitizing the gelatin, is mixed with the gelatin solution. The only drawback to this new process was the fact that the gelatin solutions could not be long preserved, especially in warm weather. This difficulty has been lately overcome by Mr. Burgess, of England, who prepares the sensitive gelatin solution in any quantity that may be desired, and, after preparation, desiccates or dries the same by spreading the solution on glass plates. The dried film is then broken up into small bits and packed away in dried condition for use. Thus prepared, it will always keep good, and only requires to be dissolved in hot water to form an excellent sensitized solution.

PETROLEUM FIRES EXTINGUISHED BY CHLOROFORM.

SOME of the fiercest and most destructive conflagrations on record have been occasioned by the burning of large quantities of petroleum. It is hardly necessary to recall instances; the frequent fires in the large oil-works in Brooklyn, the great conflagration in Philadelphia some years ago, and the fearful disaster on the Hudson River Railroad, due to the ignition of an oil-train through collision, are within every one's recollection. Various processes have been suggested for rendering the petroleum incombustible, principally, however, based on the admixture with the oil of foreign substances and their subsequent removal before using the material. Abbé Moigno, the editor of *Les Mondes*, suggests in that journal a new means, which, he states, renders the oil absolutely proof

against fire. He states that petroleum mixed in proportion of five to one with chloroform can not be ignited; it becomes not only uninflammable, but incombustible so long as the major part of the chloroform remains unvolatilized.

It is a remarkable fact, that if a quart of petroleum be poured upon a large shallow dish so that its depth will be about 0.3 of an inch, and in surfaces about three inches square, and then ignited and allowed to become well kindled, about one tenth of a gill of chloroform will extinguish the flames; and if attempts be made to relight the petroleum, the liquid will put out the match. Another experiment tried on a larger quantity of oil, though retaining the same superficial area, showed that the same amount of chloroform sufficed to repeat the result. Mixtures of explosive gases mingled with the vapors of chloroform also lose, it is stated, in a great measure, their inflammability.

The chloroform must be pure and free from alcohol. If, however, the vapor of boiling chloroform or the liquid in a pure spray be introduced into the flame of burning alcohol, the latter becomes extinguished.

The composition of chloroform gives an explanation of these facts, which, however, are nevertheless very remarkable, inasmuch as most chemical treatises admit the inflammability of the substance. The formula CH,Cl^3 leads to the decomposition by heat, with the formation of Cl^2H, and Cl and C become free. An æolipile, covered externally with alcohol and internally with chloroform, gives off clouds of carbon accompanied with intense fumes of hydrochloric acid.

EXPLOSION AND FIRING OF VOLATILE OILS.

A MIXTURE of two parts of perfectly dry permanganate of potassium with two or three parts of concentrated sulphuric acid is a most powerful oxidizing agent, owing to the separation of permanganic acid and its immediate decomposition with the liberation of oxygen. Volatile oils are violently affected by this mixture, if about ten drops are placed in a little dish and then touched with a stout glass rod previously dipped into the mixture. The following produce explosions, often most violently: oils of thyme, mace, turpentine (rectified), spike, cinnamon, origanum, rue, cubebs, and lemon. The following oils are simply imflamed, particularly if poured upon blotting-paper and touched with the mixture, though under certain still unknown circumstances explosion may occur; oils of rosemary, lavender, cloves, rose, geranium, gaultheria,

caraway, cajeput, bitter almond, and rectified petroleum. The following substances are ignited without explosion: alcohol, ether, wood spirit, benzol, chlorelayl, sulphide of carbon, and cotton. Gun-cotton and gunpowder are not ignited.

PERMANENCE OF THE HYDROCARBON GAS.

A VERY natural doubt has existed in the minds of some of our best gas engineers whether the hydrocarbon gas could have the same permanence under the influence of low temperatures as ordinary coal-gas. Considering the ease with which air or even poor coal-gas which has been naphthalized parts with an important portion of its illuminants at a low temperature, it has been argued that the non-luminous substratum of combustible gases, got from water by the hydrocarbon process, would in like manner part company with the illuminants derived from the bituminous coal distillation as soon as the mixture should be powerfully refrigerated.

Experiment, before which all preconceived notion must bow, completely disproves this hypothesis, and we are able to declare most positively, say Professors Silliman and Wurtz, that the hydrocarbon gas is far more permanent under the influence of extreme cold than any coal-gas we have been able to put to the same severe test.

The results of many careful experiments by these gentlemen show a loss of from 10 to 40 per cent of illuminating power for street gas under the influence of cold, and no loss for hydrocarbon gas.

DISTILLING SEA-WATER.

THE author of a book lately published in England, entitled *Two Years in Peru*, thus describes a simple contrivance recently devised by an English resident of that country for procuring fresh water from sea-water through the direct action of the sun's rays:

"The apparatus consists of a box of pine-wood, 1 inch thick, and which is about 14 feet long, 2 feet wide, and an average depth of 6 inches. The upper part of this box is closed with ordinary glass, which has an inclination of 1½ inches.

"At the lower edge of the glass, there is a semicircular channel, destined to receive the fresh water which is condensed on the interior surface of the glass. The salt water is let into the box to about 1 inch in depth. It is then exposed to the rays of the sun, the heat of which is sufficient to raise it to 160° or 180° Fahr. A very active evaporation then begins, and it is proved that 10½ square feet of glass will condense daily two gallons of pure water."

The author says he saw the apparatus in successful operation at Callao. There are many places on the coast of Peru, as in various other parts of the world, where fresh water is only to be got by distillation, and in such localities the device can not fail to be exceedingly useful.

MANUFACTURE OF CHLORAL HYDRATE.

CHLORAL hydrate is now manufactured on an enormous scale, some German makers supplying over 500 lbs. daily. Chlorine is passed into alcohol of at least 96 per cent. For 120–150 lbs. of alcohol the current of chlorine must be maintained for 12–14 days, in which time the temperature rises to 60°–75°, and the liquid acquires the density of 41° B. The crude product thus obtained is purified by heating it with an equal weight of strong sulphuric acid in copper vessels lined with lead. Considerable quantities of hydrochloric acid escape at first, and afterward chloral distills at 95°–100°. This distillate is redistilled, collected in glass flasks, and mixed with water; and the hydrate then formed is either poured into large porcelain basins, in which it solidifies in cakes in half an hour, or it is poured into vessels one-third full of chloroform, to crystallize.

BLEACHING IVORY AND BONES.

THE curators of the Anatomical Museum of the *Jardin des Plantes* in Paris have found that spirits of turpentine is very efficacious in removing the disagreeable odor and fatty emanations of bones or ivory, while it leaves them beautifully bleached. The articles should be exposed in the fluid for three or four days in the sun, or a little longer if in the shade. They should rest upon strips of zinc, so as to be a fraction of an inch above the bottom of the glass vessel employed. The turpentine acts as an oxidizing agent, and the product of the combustion is an acid liquor which sinks to the bottom, and strongly attacks the bones if they are allowed to touch it. The action of the turpentine is not confined to bones and ivory, but extends to wood of various varieties, especially beech, maple, elm, and cork.

NEW PROCESS FOR THE PRESERVATION OF WOOD.

A NEW process for the preservation of wood, believed to be the latest and best extant, is that of M. A. Hatzfeld. It consists in the injection of the wood, under pressure, with a solution of tannic acid and protoxide of iron. The cost of the solution in France is 13 cents for a railway-sleeper. Pieces of sound oak piles from a bridge built at

IMPROVEMENTS IN BLEACHING.

M. PIERRE ISIDORE DAVID, a French chemist, has invented the following processes:

Chlorine in the gaseous state is produced in a closed receptacle by one of the ordinary methods—for example, by the action of an acid on chloride of lime diluted with water, and is conveyed by a tube into a chamber containing the articles to be bleached, the sides of such chamber being constructed of a transparent material in order to permit the entrance of light, which assists considerably the process of decolorization. After an interval, varying with the nature of the articles to be bleached, he sends into the chamber a rapid current of carbonic acid gas, obtained by any of the well-known processes. The apparatus in which the carbonic acid is generated communicates, however, with a vessel containing liquid ammonia, the fumes of which combine with the carbonic acid, and are conveyed into the chamber, where the two gases neutralize the hydrochloric acid, and accelerate the decolorization of the materials contained therein. The ammonia should be contained in a vessel of such a shape that the evaporation surface of the liquid can be augmented or diminished according to the quantity of chlorine employed.

In the second process, permanganate is obtained by the action of peroxide or binoxide of manganese on lime aided by heat, preferably in the following manner: One part by weight of peroxide of manganese and three parts of quick-lime in powder are mixed together and submitted to a red heat for about three hours. When the heat has been continued for one hour, however, a rapid current of carbonic acid is passed through the mixture and continued till the completion of the process, the object being to superoxidize the compound. The permanganate of lime thus prepared is placed in a closed receptacle, which communicates by a tube with the bleaching-chamber, commercial sulphuric acid is gradually added, and "ozonized oxygen" is evolved. In order to accelerate the evolution of this gas, the inventor adds a vegetable acid in quantity equal to the oil of vitriol, acetic acid being preferably used.

In the third process, M. David employs phosphorus and acetic acid. The production of ozone by means of phosphorus in a moist atmosphere is well known, but the quantity thus obtained is very small. By causing air which has been previously forced through acetic acid to bubble through the water containing the phosphorus, the patentee has discovered that the quantity of ozone is considerably increased. The ozone is conveyed to the bleaching-chamber in the same manner as before describ-

ed, the air being forced through the liquids by means of a fan or any other of the well-known methods of obtaining a current either by pressure or exhaust.

The fourth process consists in the use of chalk, alum, and sulphuric acid. A saturated solution of alum is prepared at a temperature of 140° to 160° Fahr., into which powdered chalk is thrown, about equal in weight to the alum employed; sulphuric acid is then added, and the gas evolved is conveyed by a tube to the bleaching-chamber, where it effects the desired object.

It will be seen that in three of the four processes, chlorine is dispensed with, and the formation of hydrochloric acid avoided. When the articles are removed from the bleaching-chamber, it is desirable to expose them for a time to the action of the atmosphere in order to remove the characteristic smell of ozone. These processes are claimed by M. David to be applicable to the decolorization of raw or worked materials, especially those which from their shape or nature do not admit of immersion in liquid; they are also specially adapted to the bleaching of books, papers, and engravings. Oils and fatty matters may be decolorized by them; alcoholic liquids may be "improved" or "aged," as it is called, by the oxidizing properties of the ozone; fermentation may be arrested and unpleasant flavors removed; and they may be speedily converted into vinegar or acetic acid. M. David asserts that his processes will be found more economical than those at present adopted.

EFFECT OF HEAT ON TEXTILE FABRICS.

RECENT experiments on disinfection by means of heat, made by Dr. Ransom, of Nottingham, England, show that white wool, cotton, silk, and paper may be heated to 250° Fahr. for three hours without apparent injury, although the wool will show a faint change in color, especially when new. The same may be said of dyed wools and printed cottons, and most dyed silks; but one kind of white silk easily turns brown by this heat, and pink silks of some kinds are also faded by it. The same temperature will, if continued for a longer period, slightly change the color of white wool, cotton, silk, paper, and unbleached linen, but will not otherwise injure them. A heat of 295° Fahr., continued for about three hours, more decidedly singes white wool, and less so unbleached and white cotton and white silk, white paper, and linen, both unbleached and white, but does not materially injure their appearance. The same heat, continued for about five hours, singes and injures the appearance of white wool and cot-

ton, unbleached linen, white silk, and paper, some colored fabrics of wool, or mixed wool and cotton, or mixed wool and silk. It is noteworthy that the singeing of any fabric depends not alone upon the heat used, but also on the time during which it is exposed. In these experiments, the heat was obtained by burning gas with smokeless flames, and conducting the products of combustion, mixed with the heated air, by means of a short horizontal flue into a cubical chamber through an aperture in its floor, and out of it by a smaller aperture in its roof. Fixed thermometers showed the temperature of the entering and out-going currents, which represent the maximum and minimum temperatures of the chambers. A self-acting mercurial regulator maintained the temperature of the entering current at any required degree.

TESTING DYES FOR ADULTERATION.

RED dyes must neither color soap and water nor lime-water, nor must they themselves become yellow or brown after boiling. This test shows the presence or absence of Brazil-wood, archil, safflower, sandal-wood, and the aniline colors. Yellow dyes must stand being boiled with alcohol, water, and lime-water. The most stable yellow is madder yellow ; the least stable are anatto and turmeric ; fustic is rather better. Blue dyes must not color alcohol reddish, nor must they decompose on boiling with hydrochloric acid. The best purple colors are composed of indigo and cochineal, or purpurin. The former test applies also to them. Orange dyes must color neither water nor alcohol on boiling; green, neither alcohol nor hydrochloric acid. Brown dyes must not lose their color on standing with alcohol, or on boiling with water. If black colors have a basis of indigo, they turn greenish or blue on boiling with sodium carbonate; if the dye be pure gall-nuts, it turns brown. If the material changes to red on boiling with hydrochloric acid, the coloring matter is log-wood without a basis of indigo, and is not durable. If it changes to blue, indigo is present. (36)

HOP-STALK CLOTH.

IN Sweden, a strong cloth is manufactured from hop-stalks. The stalks are gathered in autumn, and soaked in water during the whole winter. The material is then dried in an oven and woven as flax. The buds of hops can be used as an esculent, and when boiled will do as a substitute for asparagus. The tendrils, when young, may be used in the same way.

ALUMINUM SILVER.—The following alloy is distinguished by its beautiful color, and takes a high polish: Copper, 70; nickel, 23; aluminum, 7; total, 100.

DETERMINING ALCOHOL IN WINES.

If to a known volume of water larger and larger quantities of alcohol are added, the density and the superficial tension of the mixtures obtained are simultaneously diminished, and consequently there is an increase in the number of drops which they form if allowed to flow slowly from a given aperture. If this aperture has constant dimensions, the number of drops corresponding to each alcoholic mixture is constant also. The difference between the numbers thus found is large enough to furnish a basis for a very sensitive alcoholometric method. The instrument proposed is a pipette holding 0.3 cubic inch. It is filled with the alcoholic liquid under examination, and the number of drops escaping is counted. From this number the proportion of alcohol is calculated by the aid of tables which the author has drawn up. Slight traces of liquids more diffusible than alcohol, such as acetic ether, greatly increase the number of drops.—*M. Ducleaux.* (2)

Improvement of Wines.—The microscopic fungi of the atmosphere play an interesting part in the alteration of wines. These grow acid, change, become filmy or oily, or take on besides a decided bitterness. All these sicknesses depend on the development of different little plants recognized and described by M. Pasteur; and this scientist, not stopping at the solution of the nature of these disorders, has sought the means of preventing them. Resting on some former observations by D'Appert, he conceived the idea of subjecting wines to the action of a very high degree of heat, so as to destroy the yeast-germs. There was no possibility of doubt as to the destruction of these germs and the prevention of any further change, but it might well be asked whether the delicacy and bouquet of certain wines would not be endangered by the effects of heating. Long-continued experiments prove not only that heating is an excellent method for preventing sickness in wines, but also that, instead of impairing their exquisite qualities, it ripens and strengthens them. The recorded minutes of tastings officially performed during the past year by several members of the Syndical Wine Commission, at the suggestion of M. Pasteur, contain decisive testimony on this point. Fine Burgundy wines, heated in bottle seven years ago to temperatures varying between 131° and 149°, appeared at the end of that time superior to the same wines not so treated. Persons who spoke with some authority, M. Pasteur says, declared that heating would in time deprive the wine of its color. The contrary is the case, when the air is excluded during the

process; the color grows livelier by heating. It was said that heating would in time alter the bouquet of fine wines, giving them dryness and too great age. On the contrary, the bouquet seems to be heightened with the lapse of time, more positively than with wines not heated. In the case of chambertin and volnay particularly, the tasters noticed this fact. M. Pasteur was led by these studies to investigate the cause of the aging of wines, and he discovered that the phenomenon was due to slow oxidation. Wine kept in glass tubes completely filled and closely sealed does not age. By increasing and regulating the aëration of wine, and particularly combining it with heating, he succeeded in manufacturing in one month excellent old wine. In short, oxygen and heat, acting on wine in certain proportions, promote instead of hindering the development of those volatile principles to which the liquid owes its perfume and part of its flavor; but this discovery is additional to those sought. What M. Pasteur did chiefly look for and did find, in giving exact and methodical rules for heating wines, is a process, applicable on a great scale, for preventing the diseases from which the common vineyard products so often suffer, and that fortunate application is a result from his researches on fermentation generally. *

A NEW REFRIGERATING PROCESS.

A NEW process of refrigeration, adapted to the preserving of food, has recently been devised by M. Tellier, a French civil engineer. It consists in maintaining, in the receptacle in which the material to be preserved is placed, a temperature of from 30° to 32° Fahr., in order to produce which the condensation of methylic ether is employed. This ether is gaseous at the ordinary temperatures, but liquefies at —22° and distills at +5.8° Fahr.

The apparatus principally consists in a cooler, in which the ether is placed. The vapors of the latter, which escape at a tension of about 1½ atmospheres and at the temperature of 58° Fahr., are compressed in a condenser at 6, 7, and 8 atmospheres. They then liquefy, and are returned to the cooler, so that there is a constant circulation.

The cooler resembles a tubular boiler, since it is traversed by a large number of tubes. The ether is placed in the body of the vessel, and a solution of chloride of calcium is pumped through the pipes, and thence, becoming cooled, is led through the receptacle in which the meat, etc., is contained. The effect of the intensely cold liquid current is to cool the air in the chambers to the freezing

* F. Papillon.

point of water, when watery vapor and atmospheric germs become deposited in the form of hoar frost. The solution is then conducted back to a reservoir, and thence through the cooler pipes again. A committee from the French Academy of Sciences, deputed to examine this invention, speak of it very highly, and state that meat thus kept for months, and subsequently cooked, was found to be in perfectly fresh condition.

DEPILATION OF HIDES.

ANDERSEN discovered that pulverized charcoal applied to sheepskins produces the depilation of the hair. Charcoal, as is well known, has the property to take up large quantities of oxygen from the atmospheric air, and the oxygen in this form seems to exert a chemical influence on the fatty substance present in the neighborhood of the glands of the hair-roots. An oxidation takes place in the pores of the skin, which destroys the glands and loosens the hair. Finely powdered charcoal is mixed with sufficient water to make a thin paste, and the hides immersed for 4 or 5 days and well turned over in the mean time, when the hair can be taken off at once. Hides treated with charcoal do not require further treatment, as is the case now with the lime process; and after being washed with water, they are ready for tanning. This will be a great advantage to the tanning trade, as leather treated in this way possesses more toughness, solidity, and flexibility. The other advantages of this treatment are great saving in time and labor, each hide weighs ½ to 1 pound more, and has less spots, the work is more pleasant and healthy, the splitting with the machine is more easily accomplished, and the cost price is the same as with lime, as the charcoal can be used over again. Animal or vegetable coal can be used in any quantity, having no deleterious property whatsoever; and for each hide 6 or 10 pounds, with the necessary quantity of water, are sufficient. The temperature should be 61° or 70° Fahr., and can easily be maintained by introducing steam into the vats. The tanning process is facilitated, as no lime is left behind to neutralize the tannic acid.

GEORGE BLOOM VAN BRUNT, San Francisco, Cal., is the author of a process of extracting from fresh raw and hashed animal fats all the fatty matters they contain in a perfectly sweet state by adding a small quantity of caustic alkalies during the first period of the melting process of such fats, thus producing slight saponification which mechanically starts the melting, while the entire process is carried on at from 110° to 200° Fahr.

RAWHIDE BELTS.

IN driving centrifugal sugar-machines, Mr. J. Mason, of the Island of Barbadoes, found the use of the ordinary leather belts to be troublesome and expensive. He, therefore, substituted belts of raw cowhide, simply dried in the sun, cut perfectly straight, and the joints, square and even, stitched with saddler's hemp-thread. He states that in practice, a belt of this description will last four times longer than, and cost only one fourth as much as, a leather belt. He uses an 8-inch belt of this kind to drive a line of 3-inch shafting, from which 2½-inch belts drive the sugar-machines.

TESTING BELTING-LEATHER.

M. EITNER proposes the following simple method of determining the value of leather employed on belting. A cutting of the material about 0.03 of an inch in thickness is placed in strong vinegar. If the leather has been thoroughly acted upon by the tannin, and is hence of good quality, it will remain, for months even, immersed without alteration, simply becoming a little darker in color. But, on the contrary, if not well impregnated by the tannin, the fibres will quickly swell and, after a short period, become transformed into a gelatinous mass.

PALM PAPER.

MR. JAMES P. HERRON, of Washington, D.C., has invented a process of making paper from varieties of the palm. The material is cut or torn into pieces of suitable size, then cooked in a close digester, with thorough agitation and under steam-pressure, in a weak solution of alkali, naphtha, benzine, or soap; then it is completely ground, while steam passes freely through the grinder and intermingles with the stock, reducing, bleaching, and finally washing it.

TO MAKE PAPER TRANSPARENT.

THE best kind of paper is the class known as wove, not laid, paper. A varnish formed of Canadian balsam dissolved in turpentine supplies an excellent means of making paper transparent. The mode by which we succeeded best was to apply a pretty thin coating of this varnish to the paper, so as to permeate it thoroughly, and then give it a good coating on both sides with a much thicker sample. Keep the paper warm by performing the operation before a hot fire, and apply a third or even a fourth coating until the texture of the paper is seen to merge into a homogeneous translucency. Paper prepared in this way has come nearer than any other to our ideal of perfection in transparent paper. (1)

WATER-PROOF PAPER.

A WATER-PROOF paper, transparent and impervious to grease, is obtained by soaking good paper in an aqueous solution of shellac and borax. It resembles parchment paper in some respects. If the aqueous solution be colored with aniline colors, very handsome paper, of use for artificial flowers, is prepared.

INCOMBUSTIBLE PAPER AND INK.—An English inventor has secured letters-patent for an incombustible and fire-proof ink. The pulp for the paper is composed of vegetable fibre, one part; asbestos, two parts; borax, one tenth part; and alum, two tenths parts. The ink can be used either in writing or painting, and is made according to the following recipe: Graphite, finely ground, twenty-two drachms; copal or other resinous gum, twelve grains; sulphate of iron, two drachms; tincture of nut-galls, two drachms; and sulphate of indigo, eight drachms. These substances are thoroughly mixed and boiled in water. The graphite can be replaced by an earthy mineral pigment of any desired color.

ARTIFICIAL ALIZARIN IN PRINTING.

HITHERTO, artificial alizarin has been chiefly used as a steam color, but it can also be employed like garancin and *fleurs de garance*. To prepare the dye beck, chalk to the extent of 1 per cent of the alizarin-paste to be employed is stirred into the beck, which is heated to 190° Fahr. The goods, previously printed with the mordants, aged, dunged, and washed, are unwound into the beck, and heated quickly to a boil. The dyeing is complete in ten minutes. The alazarin in the spent bath, in combination with the excess of chalk, is precipitated with hydrochloric acid, and recovered from the precipitate thus formed. The dyed pieces are washed in warm and cold water, and then three times, using each time ½ lb. soap per piece: the two first soap-baths at 145° and the third at 190° Fahr. They are then placed in a weak solution of chloride of lime for half an hour at 88° Fahr., washed again, dried, and finished.—*Farber Zeitung*.

RECENT PRINTING-PRESS IMPROVEMENTS.

IN the working of nearly all printing-presses, the sheets of paper are supplied by hand, the workman being known as a "feeder." Each sheet must be taken up singly and exactly placed on the feed-board, where it can be seized by the press-nippers at the proper moment, and carried to the types. Any carelessness on the part of the feeder

results in bad printing and the spoiling of sheets. Measured by the manual force expended, the feeder's labor is slight; but no press can be run, not even for the smallest job, unless the feeder is on hand to place the sheets, while his inexorable weekly wages are a serious expense in every printing-office. Many have been the attempts made, extending over a period of twenty-five years past, to substitute mechanism for this species of hand-labor, but without much success until the present time. We have recently had the pleasure of witnessing, at the extensive press-rooms of the *Independent* newspaper, Rose street, in this city, the practical operation of a mechanical feeder which is, apparently, the perfection of success. It takes up the sheets separately upon a steel point, carries them forward and delivers them to the nippers, between the adjustable guides, with almost infallible accuracy. Every contingency seems to be provided for. If by any possibility the device fails to place the sheet properly, or fails to feed, the press instantly stops. If two sheets in the pile are by any means tucked or folded together, or if two sheets are lifted, the press stops. All inaccuracy of feeding, or the running through of doubles or "packets," is prevented, and much spoiled work obviated. The first move or slide of the upper sheet of the pile is given by a rubber-faced presser, no air-suction being used. The apparatus is suited to nearly all presses, and is quickly adjustable to sheets of various sizes. (83)

NEW PROTECTING COMPOUND FOR IRON SHIPS.

DISSOLVE thirty-four ounces of shellac in eighty ounces of wood alcohol, which is allowed to stand about twenty-four hours. Then add thirty ounces of Venetian red, and thirty-five ounces of sulphate of lime, and thoroughly mix by passing it through a paint-mill.

The paint is now ready for use, and is applied with a brush in the same way as ordinary paint, and will dry instantly, so that the vessel may be lowered into the water within an hour after the paint has been applied to the bottom.

For vessels navigating fresh water, or both salt and fresh water, the proportions of the Venetian red and the sulphate of lime used may be diminished. This paint may also be used upon the inside of the iron-work of the vessel. It is the invention of Samuel Williams, of New-York City.

A RED INK WHICH RESISTS THE ACTION OF MOST CHEMICALS.—This ink is a solution of carmine in soluble glass, and must be kept in a bottle, with a well-oiled cork.

NEW FRENCH LIFE-SAVING RAFT.—An extraordinary safety-raft has recently been invented in France. It is described as large enough to support from 400 to 600 persons, as neither incumbering nor requiring any alteration in the arrangement of vessels, and as needing only a minute or two to inflate and launch it. It is an air-tight mattress, with a surface of nearly 900 square feet, inflated in one minute, it is said, from a reservoir fixed in the engine-room, and always charged with air under a pressure of fifteen atmospheres. When not in use, it is rolled up, and takes no more room than a boat. When inflated, it falls over the side of the vessel, against which it is retained by ropes till all the persons on board are transferred to the raft. Three strong spars, passing through the whole length of the raft, keep it flat and solid.

SCULPTURE BY THE SAND-BLAST.

SOME new and interesting applications of this invention were lately described at a meeting of the students of the Polytechnic College, Philadelphia, Pa.

Samples of raised lettering on marble, also of ground uncolored and of stained glass ornamented by the process, were exhibited. Samples of thick plate-glass, perforated by the sand-blast with well-defined holes ¼ inch in diameter, were shown. The holes for the axles of the glass plates of electrical machines can be safely cut in this way.

The lettering of the block of marble had been done by first grinding and polishing one of its surfaces, attaching the stencils (letters of the size and shape required cut out of plate-metal), and then blowing sand, by means of a jet of steam, on the surface, until, where unprotected by the stencils, it is cut away to the required depth, leaving the letters in bold relief. The stone to be cut is placed upon a small truck, and then removed backward and forward upon a horizontal table, directly under the nozzle through which the sand is blown. The nozzle, which stands vertically over the table, has the pipe for the sand, entering the upper end, passing in the line of its axis, toward its lower opening. The pipe from the steam-boiler enters through the side of the nozzle near its upper end, so that, when in operation, steam surrounds the tube through which the sand runs. The latter is connected by a rubber pipe, with a box of sand set about it. The machine is in operation at the stone-yard of Messrs. Struthers & Son, who by the sand-blast have sculptured designs on the blocks of Cleveland stone for the walls of the grand staircase of the new Philadelphia Academy of Fine Arts, Broad st. The design on each stone is about 20 inches by 10 inches,

representing foliage, and was cut to the depth of five eighths of an inch in ten minutes. When cutting glass, the sand is impelled by a current of air from a reservoir, kept under pressure by a small blowing-engine. In such a case, the stencils need not be of metal. Rubber, and even thin muslin, will protect the glass.

NEW METALLIC DECORATIONS.

AT a recent meeting of the Royal Institute of British Architects, Mr. C. H. Cooke introduced to the profession a new style of decoration, recently perfected in Paris, and applicable to iron, brass, and zinc, which is expressed simply and plainly as "cut work."

The cutting of these metals was effected by a steam saw, the hardness and make of the saw being in reality the secret of the whole work; and this tool, as was shown by the various specimens which were exhibited, offered the greatest facilities for the conception and working out of the most intricate and delicate design obtained by any other means. The zinc work, it was believed, would stand in this country, as at Paris, the effect of the weather, without painting.

This method of cutting through hard metals has been brought to great completeness, and by it could be cut brass and copper three inches thick and wrought-iron one inch thick. The face of the work could be chased or engraved as desired; and after the pattern required had been cut by the saw, it could be heated, and the twist to the ends or points, so frequent in wrought work, could be given, and certain portions of the ornamental work raised or depressed as desired; and this forms a combination in metal-working hitherto unknown.

The cost was moderate, being more than a third less in cost than for the same kind of work in wrought-iron as usually done. It was stated that this mode of working in metals offered a valuable opportunity for the operation of the architect. It would be idle to attempt to enumerate the various ways the work might be applied, for every architect and actual metal-worker must be aware that it was almost unlimited in its applications.

FISH-SCALE ORNAMENTS.

AMONG recent patents is that of Eduard and Julius Huebner, of Newark, who have invented certain new and useful improvements in preparing fish-scales for use in the arts, of which the following is a specification:

The object of the invention is to utilize the scales of several varieties of fish hitherto thrown away as useless,

and prepare them for application in the arts, by producing articles of jewelry, artificial flowers, and similar objects. This invention consists in the process of cleansing and purifying the scales till the clear, horny substance or core of the same is obtained, which produces a new article of manufacture, which may be stamped into various ornamental shapes and dyed in all colors for use in the arts.

Large scales are the most advantageous, taken from fresh fish. Old scales can not be used, as they lack elasticity and clearness. The fresh scales are exposed for twenty-four hours to the action of pure salt water, for loosening and partially separating the outer layers of organic matter. They are then transferred to distilled water, being placed every two or three hours in clean water and washed therein five or six times, which renders the scales soft and clear. Each scale is then carefully rubbed with clean linen rags, then passed through a press having a linen lining so as to remove the moisture in the scales. The scales are finally placed for one hour in alcohol, and again rubbed and pressed, when they are dry and have a perfectly clear appearance, a mother-of-pearl-like hue, and great elasticity and durability.

The scales are used in this prepared state, or they may be dyed with aniline and other colors, in the usual manner, to be stamped into various kind of ornamental shapes, leaves, and flowers, and applied to the manufacture of jewelry and artificial flowers, for embroidering and inlaying wood, and other uses in the arts.

TO RENDER GLASS OPAQUE OR FROSTED.

A SHEET of ordinary glass, whether patent plate or crown does not matter, is cleaned; and if only portions of it are to be frosted, those are left bare, while the others are protected by mechanical means in any simple manner. Some fluor-spar is rubbed to a fine powder and mixed with concentrated sulphuric acid, so as to make a thin paste, and this is then rubbed by means of a piece of lead upon those parts of the glass required to be rendered opaque. A fine frosted outline or design may thus be produced upon a sheet of smooth transparent glass. To finish the operation, the glass is gently heated in an iron vessel covered with a funnel passing up the chimney, to get rid of the noxious fumes that are given off; on cooling, the plate is washed with a diluted solution of soda or potash, to remove any acid yet remaining, and is then rinsed in water. Focusing-glasses for the photo-camera, and development-glasses for pigment-printing, can be prepared in this way at very little expense.

GOLD FOR ILLUMINATING.

PROCURE a book of leaf-gold, take out the leaves gently and grind them in a mortar with a piece of honey about the size of a hazelnut, until it is thoroughly intermixed with the gold, then add a little water and rework it; put the whole into a vial and shake it well. Let it remain an hour or two, and the gold will deposit at the bottom of the vial. Pour off the liquor, and add weak prepared gum in its stead, sufficient to make it flow freely from the pen or camel's-hair pencil. When required for use, shake it occasionally.

ORNAMENTING METAL SURFACES.

A NEW process for ornamenting metal surfaces, by K. Goddard, of Richmond, N. Y., consists in plating, electroplating, or otherwise covering a plate, bar, or ingot of soft metal with a thin film of harder metal, and then rolling out or pressing the ingot into a sheet; whereby the coating is broken into irregular forms, and a marbleized appearance produced on the surface of the sheet.

MANUFACTURE OF PLATE-GLASS.

THE manufacture of plate-glass, as now conducted by the Thames Plate-Glass Company, at Blackwall, London, is as follows:

The principal successive operations necessary to convert a mixture in the pot into a finished sheet of plate-glass are six in number, and may be described under the heads of melting, rolling, annealing, grinding, smoothing, and polishing. The pots are of Stourbridge clay, made on the premises, and are filled with the mixture, the chief ingredients of which are silica, sand carefully dried, lime, sulphate of soda, broken white glass, and a little arsenic. The sand is obtained from Germany. After remaining in the furnace for about sixteen hours, the contents of the pot are fit for removal. The molten mass is then run over the surface of the rolling-table and the roller passed quickly over it. The glass commences to solidify almost immediately; and while in a thick, tenacious condition, and of a rich golden tint, is rapidly transferred into the annealing furnace. The rough sheet, as it may now be termed, is taken from the annealing furnace to the grinding-room; of these there are several, containing about a dozen grinding-stones, or, more properly, beds or tables, upon which the plate is laid flat. The grinding frames consist of wooden boards joined together and armor-plated, so to speak, at intervals over the rolling or grinding surfaces with strips of wrought-iron. These strips, when first screwed on to the frames, are half an inch in thick-

ness, and when removed measure less than one eighth inch. The frames are mounted upon a spindle, and a see-saw, semi-rotary movement is imparted to them by shafting running underneath the beds. They are also capable of being shifted by a simple slot connection so as to work over any part of the surface of the sheet as required. The grinding beds are of stone, and measure about 16 feet by 11 feet. The materials used as the grinding agents are coarse sand, fine sand, and emery. A jet of water plays on the surface of the sheet during the whole of the operation.

Between the grinding and polishing processes there is an intermediate process called smoothing, in which two sheets of glass are employed. One is laid over the other, and caused to move over it in a manner similar to that in grinding. Emery is placed between the two surfaces. On entering the polishing-room, the attention of a visitor is at once arrested by the reddish tinge of every thing, extending to the dresses of the men and women engaged therein. This is due to the use of the red oxide of iron which is the polishing agent. The sheet to be polished is laid flat on a table, so as to be perfectly flush with the edges. The rubbers are of flannel and mounted on a frame, which carries them backward and forward over the sheet. The table, at the same time, has a lateral reciprocating motion, so that the whole surface of the sheet comes successively under the action of the rubbers. The largest plates measure about 15 feet by 10 feet, and the maximum thickness is about 1½ inches. One eighth of an inch is allowed for loss in the operations we have described. A nest of six boilers, and three vertical steam-engines, two of 70 horse-power and one of 60 horse-power, supply the necessary motive-power.

IMPROVED ARTIFICIAL IVORY, CORALS, ETC.

JULIUS FRAUENBERGER, New-York City.—This is a composition for producing artificial corals, ivory, and similar articles, made of caseine, mixed in suitable proportions and boiled, with a varnish-like solution of copal in concentrated liquid ammonia and alcohol, to be colored and prepared for the various applications in the arts.

PRESERVING BRICK-WORK.

THE exclusion of damp from brick-work has long been an important problem with builders. It is stated that one of the most effective methods of accomplishing this object is the following: Three quarters of a pound of mottled soap are dissolved in one gallon of boiling water, and the

hot solution spread steadily with a flat brush over the outer surface of the brick-work, care being taken that it does not lather; this is allowed to dry for twenty-four hours, when a solution, formed of a quarter of a pound of alum dissolved in two gallons of water, is applied in a similar manner over the coating of soap. The soap and alum form an insoluble varnish, which the rain is unable to penetrate, and this cause of dampness is thus said to be effectually removed. The operation should be performed in dry, settled weather.

Another method is to use eight parts of linseed-oil and one part of sulphur, heated together to 278°, in an iron vessel.

IMPROVED ARTIFICIAL STONE.

ERNEST L. RANSOME, San Francisco, Cal.—This is an improved process for indurating and removing the excess of moisture from artificial stones by the aid of heat and moisture. If the stone contains soluble silica, it is first immersed in a solution of any of the compound silicates. The maximum temperature of the solution should be about 212° Fahr. When the stone has been subjected a sufficient length of time to the action of this bath, the stones are removed and placed in a separate vessel. The stones are next surrounded with an atmosphere of about their own temperature, which is moistened by steam, the object being to obtain a greater quantity of moisture in the atmosphere surrounding the stone than would result from the conversion of the moisture in the stone to steam. After maintaining this moist atmosphere at a temperature long enough to convert the moisture in the stone to steam, the amount of moisture is gradually reduced, while carefully regulating the temperature. Artificial stone which does not contain soluble silica need not be subjected to the hot bath, but will be seasoned and indurated by being subjected to the moist atmosphere and subsequent dry heat. By the above described process, the surface of the stone is speedily indurated, while heat and moisture are conveniently conveyed to the mass, and by the use of the atmospheric treatment the obnoxious surface cracks, consequent upon variable shrinkage of the mass, and so frequently met with in artificial cement stones, are prevented.

SAFFRANIN.—If mixed with strong sulphuric acid, this dye-stuff develops a fine blue tint, becoming emerald-green by addition of a little water. By suitable additions of water and acid, nearly all the prismatic colors can be produced.

THE REQUISITES FOR GOOD MORTAR.

To obtain a good mortar, says Graham Smith, as much depends on the character of the ingredients and the manner of mixing them as on the goodness of the lime itself. It does not necessarily follow that, because a lime is good, the quality of the mortar will be good also. The best lime ever burnt would be spoilt by the custom, common among some builders, to mix with it alluvial soil and rubbish taken from the foundation-pits of intended buildings. The sand should be hard, sharp, gritty, and, for engineering purposes, not too fine; it should be perfectly free from all organic matter, and with no particular smell. Good sand for mortar may be rubbed between the hands without soiling them. The water should also be free from all organic matter, and on this account should never be taken from stagnant ponds. The presence of salt in sand and water is not found to impair the ultimate strength of most mortars; nevertheless, it causes the work to "nitrate," or, as it is commonly termed, "saltpetre," which consists of white frothy blotches appearing on the face of the structure. It also renders the mortar liable to moisture, and for these reasons should never be present in mortar intended for architectural purposes, although for dock-walls and sea-works it may generally be used with advantage and economy.

Sand is used to increase the resistance of mortar to crushing, to lessen the amount of shrinking, and to reduce the bulk of the more costly material, lime. Water is the agent by which a combination is effected, and, as sand does not increase in volume by moisture, it necessarily follows that no more of the aqueous element should be employed than is absolutely necessary to fill the interstices between the sand, and render the whole into a paste convenient for use; and the greater strictness with which this is adhered to the more compact and durable will be the mortar.

IMPROVEMENT IN LAYING CEMENT PIPES.

JACOB LOEFFLER, New-York City.—By this invention, a continuous and solid pipe may be constructed directly on the ground, dispensing with special places of production, loss of breakage by shipment, and other difficulties. The invention consists of a moulding flask, constructed of detachable exterior sections, suitably supported on the ground, and eccentrically adjustable core sections, which are flanged in such a manner that an overlapping joint of the pipe sections is produced as they are formed consecutively, one after the other. The core sections are withdrawn from the finished pipe sections, by contracting them, by means of a central shaft and cam eccentrics.

IMPROVED MODE OF SECURING PLASTER TO WALLS.

PATRICK H. POWER, New-York City.—This invention consists of a support for preventing the plastering from becoming detached from the laths. A network of wire-cloth or other suitable material is laid over the plastering and secured to the joists, through the mortar, by nails or screws. This wire is placed over the last coat of mortar, and the coat of hard finish laid over it.

CEMENT FOR CAUSTIC LYE TANKS.—The tanks may be formed of plates of heavy spar, the joints being cemented together by a mixture of 1 part of finely-divided caoutchouc, dissolved in 2 parts of turpentine oil, with 4 parts of powdered heavy spar added.

ARTIFICIAL FURS.

MR. TUSSAUD, of London, suggests an ingenious way of preparing the hair or fur of animals for use without employing the skin. The process consists in first soaking the fur in lime-water to loosen the adhesion of the hairs. After washing and drying, the piece is stretched upon a board, fur side up, and a solution of glue laid over it, care being taken not to disturb the natural position of the hairs. After the glue has hardened, the skin may be pulled off, leaving the ends of the hairs exposed. The latter are then washed with proper substances to remove fat, bulbs, etc. An artificial skin of gutta-percha, or other water-proof substance, is next laid on top of the glue and allowed to dry so as to form a continuous membrane, when the glue is washed out with warm water. These artificial skins are entirely free from any animal odor, and are more durable, lighter, and more pliable than the natural ones.

NEW PROCESS FOR MAKING SILVERED TELESCOPIC MIRRORS.

M. A. NICOLE states that he has succeeded in producing telescopic reflecting mirrors cheaply and easily by the electroplating process. He takes the mould of a concave surface, made of a mixture which is either an electrical conductor itself or else a non-conductor metallized by the aid of nitrate of silver and phosphorus dissolved in sulphide of carbon. In either case, the mould is plunged in a bath of galvanic silver, where the current conducted very slowly to the mould determines a deposit of excellent quality.

When the silver has reached a thickness of 0.015 inch, the bath of that metal is replaced by one of copper, so as

to obtain a solid backing. The mould is then dissolved or melted and the mirror removed, nothing further being necessary than a light polishing. M. Nicole adds that he has produced perfect mirrors of four inches in diameter n this manner.

PRESERVING CLOTHING FROM MILDEW.

THE ingredients are proportioned as follows: Alum 2 lbs. dissolved in 60 lbs. of water, blue vitriol 2 lbs. dissolved in 8 lbs. of water, to which is added gelatin 1 lb. in 30 lbs. of water. A still further improvement is said to be effected by acetate of lead, ½ lb. dissolved in 30 lbs. of water. The solutions are all hot and separately mixed, with the exception of the vitriol, which is added cold. The inventors claim that the process is cheap, and does not interfere with the strength of the goods.

PURIFICATION OF TALLOW AND LARD.

DR. DOTCH states that tallow and lard can be kept from getting rancid by the following process: The tallow or lard is first treated with carbonate of soda in the proportion of 2 pounds of soda to every 1000 pounds of lard, and is then subjected to a digestion with alum in the following manner: 10 pounds of alum are dissolved in 500 pounds of water, and 1 pound of slaked lime added to the solution and boiled. This solution is stirred well with 1000 pounds of lard at a temperature of 150° or 200° Fahr. for about half an hour. The liquor is then separated from the lard, and the lard is treated with the same amount of pure water again. This lard will keep for an exceedingly long time. The fact is that the alumina in the alum applied acts very readily in a disinfecting manner upon those compounds which are liable to give rise to rancidity. The lime is added to the alum in order to render the alumina more active by its giving up some of the acid to the lime. This treatment has also the advantages of restoring the original flavor and of producing a lard of a greater whiteness. (83)

SOLIDIFIED TEA.

A NOVEL mode of preparing tea for the retail trade consists in compressing the leaf into small blocks. The advantages of the solidified tea, as it is termed, consist in a gain, claimed to be from 30 to 40 per cent, in the process of solidifying, both in strength and flavor. The reason ascribed is that the enormous pressure brought to bear on the leaf crushes the small cells, which contain the essential strength and real flavor of the tea, which is, to a great extent, wasted in using tea not so treated. Theine, the

essential property in tea, has a tendency to prevent the decay of bone, hence the natural craving after tea by most elderly persons. Now, the inventor considers that the process of solidifying thoroughly brings to the surface the theine in tea, thus rendering it medicinally superior to the article not so treated. The many properties thus set free also insure, it is believed, an efficacious antidote to nervousness. As much strength is obtained in five minutes from the solidified tea, it is claimed, as can be drawn out of the same tea, not solidified, in five hours. The block, weighing four ounces, is divided by grooves into half ounces, so that the customer can calculate how much should be used in a week or a month.

IMITATION EMBROIDERY.

HENRI FRANÇOIS TIMOTHÉE MÉGRAND, Paris, France, assignor of one half his right to Edward Vernon, same place.—A strip of any suitable fabric, such as tape, is first impregnated with a strong gum, in order to impart the necessary stiffness. It is then cut on one or both edges, according to any desired pattern, by means of machinery already patented by this inventor. The strip is then passed through another machine, also patented by M. Mégrand, whereby it is covered with threads, which are wound by a rotating thread-carrying arm as it is drawn through the machine; or the strip may be covered by a machine, described in another patent of the inventor, in which rotating arms wind threads around the strip at the same time that shuttles carrying other threads form with the first named a kind of woven edge to the strip. In either case, the surfaces of the strip are so covered with threads as to resemble satin stitch when sewed to any fabric.

WATER-PROOF PAPER.

A NICE article, transparent and impervious to grease, is obtained by soaking good paper in an aqueous solution of shellac in borax. It resembles parchment-paper in some respects. If the aqueous solution is colored with aniline colors, very handsome paper for artificial flowers is procured.

ERASIVE SOAP, TO REMOVE GREASE AND STAINS FROM CLOTHING.—Two pounds of good Castile soap, half a pound of carbonate of potash, dissolved in half a pint of hot water. Cut the soap in thin slices, boil the soap with the potash until it is thick enough to mould in cakes; also add alcohol half an ounce, camphor half an ounce, hartshorn half an ounce; color with half an ounce of pulverized charcoal.

A MECHANICAL HEARER AND WRITER.

AN ingenious idea has been started, and experiments made, by Mr. W. H. Barlow, F.R.S., relating to the possibility of the human voice itself recording upon paper its own articulated sounds.

He has a small speaking-trumpet about four inches long, the end of which is about two inches in diameter, and has a thin skin stretched across. A light arm of aluminum carrying a pencil is pressed by a slight spring upon the centre of this membrane, and, moving with it, marks on a traveling slip of paper each vibration—in fact, in a similar way to the sphygmograph.

On speaking into this trumpet, it is noticed that each sound has its own particular character, and makes its own particular mark. A diagram of the word "communicate" spoken twice is here shown, and it will be noticed

how slight is the difference between the marks of the two utterances.

Mr. Barlow has very lately explained his ideas on this subject, illustrated by the apparatus, before the Royal Society, as being at present in a crude state; but it is evident that they contain the germ of what may prove ultimately to be most valuable in science in every-day use.

He is far from thinking that every letter of the alphabet can be recorded, but words can be so formed by phonetic symbols as to be read by persons who study them. In reading a book, we do not read each particular letter in the words, but we take each word as it stands, a good deal as the Chinese words are taken—a symbol of an idea.

It may be added that the difference in the action between whispered sounds and those spoken aloud is not so great as might have been expected, but that there is a curious difference in the markings of the same words when spoken by different individuals.

DR. KREBS calls attention to the fact that the thermometers of even the best makers are liable to read too high to the extent of a whole degree in reference to the position of the freezing-point of water, and he shows that this is in great part due to the use of water derived from rain or melted snow, and containing in solution a quantity of air or other gases.

LETTER-BOX INDICATOR.

IN France, when a letter-carrier makes a collection from the boxes, he is required to insert, from the inside of the box, two cards, which appear in slits on the outside of the box, indicating the number of the collection made, and the day of the week. This change can only be effected from the inside, to that every letter-carrier is liable to detection if he omits to make his regular collections. This is one of the public matters which they manage well in France.

SMALL LENSES.

MR. EDWARD L. WILSON, of the Philadelphia *Photographer*, examined at the establishment of Ross & Co., London, some bits of glass that were more valuable than diamonds of the same size—namely, some microscope lenses $\frac{1}{10}$ of an inch in diameter. Think of being able to place fifty of these lenses side by side on a line only one inch long; each lens being perfectly ground and corrected.

SENSITIVE PHOTO-PAPER.

SENSITIVE photo-paper, which will keep for a considerable time without deterioriation in any respect, is made by Mr. H. T. Anthony, of this city, as follows:

To thirty grains of nitrate of silver in an ounce of water, add two grains of citric acid. After this is dissolved, add ammonia until precipitation ceases. Then re-dissolve with nitric acid, and leave the solution so that a small proportion of the precipitated citrate of silver remains. Let that settle perfectly, and then add ten drops of nitric acid to every two quarts of solution. Sheets of the ordinary albuminized paper may be sensitized by floating for a minute and a half. No trouble from bubbles. The paper is more sensitive in printing than the ordinary paper, and tones splendidly. The paper is fumed in the usual way with strong ammonia. Paper made in this way will be found just as white at the end of five days as when first prepared.

A NEW liquid compound by James Clausen, New-York, to be used for burnishing and finishing boots, shoes, and other leather goods, is produced of ground nutgalls, extract of logwood, Castile soap, and glycerine, mixed in boiling water, for being added to the common burnishing-ink in use.

M. CLOEZ finds that articles of bone and wood may be bleached to "a dazzling white" by exposure to light under the surface of spirit of turpentine. The article should not touch the bottom of the vessel. Even in the dark the action takes place, but more slowly.

MANUFACTURE OF CARBONIC ACID.

THE Société Général de Métallurgie employ an improved process, by means of which a much purer carbonic acid gas can be obtained, with the minimum amount of dilution by carbonic oxide, azote, or oxygen, which latter especially is found to be very injurious to the hot juices that have to be treated in the sugar processes.

The principle consists in first transforming in a gazogene a combustible into oxide of carbon and other gases, and then taking these gases through a reverberatory furnace, where, by means of hot air, the gases are burnt to carbonic acid at a high temperature. The resulting current of gas is led through a chamber or pan containing carbonates, calcareous or otherwise, and from these it extracts a further amount of carbonic acid gas, which enriches and is added to the resulting products. Since the combustible is not in contact with the calcareous agent, the lime can not contain any cinders, and is thus much more suitable for after-use.

The apparatus is composed of a gazogene or generator of gas, which receives the combustible; of a furnace, partly reverberatory, for the combustion of the gas, and partly a pan for the reception of the carbonates, and also of a hot-air apparatus or heat generator. It results from the form of the apparatus that all the hot and burnt gases traverse the whole of the mass to be decomposed; also that the pan has a very shallow depth, especially if compared with the lime kilns recently constructed, and that, consequently, it is much easier to inspect. It has further a complete security against the choking up so common in the ordinary kilns, especially when the calcareous matter falls in the condition of dust. In the new furnace, the combustible is not mixed with the lime or chalk, and there is thus no tendency to form those fusible silicates, which so easily form conglomerations in ordinary furnaces.

The charging is effected by means of boxes always filled with carbonates, and closed by a cover, so that when the inner flap is opened to receive a charge, no appreciable quantity of air is admitted with it. The combustible gases produced by the gazogene are burnt in a most thorough manner by means of divided burners, so that the combining gases are mixed in very thin sheets in the most perfect manner possible. This insures the perfect combustion of the carbonic oxide into carbonic acid, without any appreciable excess of oxygen being admitted. The gases, at their exit from the furnace, are cooled by traversing a heat regenerator in the form of cast-iron pipes of serpen-

tine, in which the cold air going to produce the combustion of the carbonic oxide, enters at the bottom, and is thus first heated by the waste heat of the escaping carbonic acid.

This arrangement makes the process a very economical one in the amount of fuel required, as no heat is wasted. The previous transformation of fuel into gas by a gazogene enables complete combustion to be effected with a minimum excess quantity of oxygen. In combustion by the ordinary furnace and grate, the quantity of air used must be at least twice the theoretical quantity required, and, as already pointed out, this is excessively injurious in the sugar processes. (106)

ACTION OF SULPHUROUS ACID ON VEGETATION.

ANGUS SMITH states that this Act requires extension and greater stringency, in order that the public wrong against which it is leveled may be effectually dealt with. In Germany, where the same evil exists, much good has been accomplished by legal enactments; and it has been found there, as elsewhere, that it pays to retain the sulphurous vapor, transforming it into sulphuric acid. It has been found, indeed, that there is no other remedy; for when the furnace chimneys are carried higher, the fumes only go further, increasing the area of damage, and, besides, by the increased draught more metalliferous dust is carried into the atmosphere. Careful investigations relative to the effect of acid vapors on vegetation have been conducted in Germany, and it has been found that sulphurous acid is pernicious to plants when it exists in the air to a greater extent than one part in 200,000 or 300,000 parts, and is much more detrimental than arsenious acid. Speaking of the effect of the vapors from the Freiburg works, where zinc, copper, and lead are produced, arsenic and sulphur being present in the ore, Freytag says that the leaves of plants exposed to their influence die before their time, the cereals vegetating for a time, but bearing no grain. Stoeckhardt says that herbs, turnips, beetroot, kohl-rabi, dahlias, and all plants with strong leaves, suffer in a lesser degree. Fruit trees under such an influence seldom give any fruit, even in a good year. He observed that the trees which were much exposed were stripped of their leaves. A plant has been known to wither in two hours when there has been only a one-thousandth part of sulphurous acid in the air; and the effect was yet striking when the proportion was nine times less. With as little

as one ten-thousandth part of acid in the air, the leaves of plants have been destroyed in forty-eight hours, without, however, quite killing the plants. Angus Smith says, "The air of Manchester will allow no plants to grow." From his own observation, he is able to believe in the slow dying of trees after several years of exposure to air with acid gases in it to an extent much smaller than what a chemist would probably call "a mere trace." The air of Manchester contains acid, and hence the plants will not grow. Yet the rain of Manchester contains no more acid than the eighty-thousandth part. This is a proportion called "incredibly small," and yet it is large compared to that found at a distance from the town, where, nevertheless, the vegetation is not perfect. (106)

STEARIC ACID MANUFACTURE.

CARBON sulphide is used by Deisz to increase the fluidity of the oleic acid, so that the warm pressure of the crude stearic acid may then be dispensed with. The addition of the carbon sulphide may be made either before or after the cold pressing of the stearic acid. The crude fat acid is melted in a special apparatus, and 20 per cent of carbonic sulphide is mixed with it while in the fluid state. It is then left to cool, and subjected to cold pressure. The stearic acid thus obtained should be free from oelic acid.

SOLVENTS FOR GUTTA-PERCHA.—R. Boettger states that chloroform and carbon bisulphide are the best solvents for gutta-percha, the former liquid readily dissolving this substance, if previously cut into small fragments. The solution clears perfectly on standing. If evaporated on a plate, the gutta-percha is left as a compact white film, possessed of all its original properties.

ARTIFICIAL CHALK.—In preparing soda-water, a gypsum results from the action of the oil of vitriol on the limestone employed; this is mixed with the lime-mud obtained in causticizing soda ash; the whole is then eleutriated, and the liquid containing the finer portions in suspension is run off and allowed to settle; the powder is then pressed into molds and dried. (36)

THE method of producing oleopalmitine chemically free from stearine, by the addition, during the process of melting the fat, of a certain proportion of glycerin, substantially as set forth.

DESTRUCTION OF DOMESTIC INSECTS.—Hirzel asserts that an aqueous solution of sulphurous acid is most effective for the destruction of bed-bugs and all their kindred. It suffices to drop the solution into the fissures, holes, etc., where those creatures are supposed to hide.

SOLVENTS FOR RUBBER.

FOR the information of correspondents, several of whom have made inquiries on the above subject, we give the following :

The proper solvents for caoutchouc are ether (free from alcohol), chloroform, bisulphide of carbon, coal naphtha, and rectified oil of turpentine. By long boiling in water, rubber softens, swells, and becomes more soluble in its peculiar menstrua; but when exposed to the air, it speedily resumes its pristine consistence and volume. Industrially, the etherial solution of caoutchouc is useless, because it contains hardly more than a trace of that substance. Oil of turpentine dissolves caoutchouc only when the oil is very pure and with the application of heat; the ordinary oil of turpentine of commerce causes india-rubber to swell rather than to become dissolved. In order to prevent the viscosity of the india-rubber when evaporated from its solution, one part of caoutchouc is worked up with two parts of turpentine into a thin paste, to which is added $\frac{1}{4}$ part of a hot concentrated solution of sulphuret of potassium in water; the yellow liquid formed leaves the caoutchouc perfectly elastic and without any viscosity. The solutions of caoutchouc in coal tar, naphtha and benzoline are most suited to unite pieces of caoutchouc, but the odor of the solvents is perceptible for a long time. As chloroform is too expensive for common use, sulphide of carbon is the most usual, and also the best, solvent for caoutchouc. This solution, owing to the volatility of the menstrum, soon dries, leaving the latter in its natural state. When alcohol is mixed with sulphide of carbon, the latter does not any longer dissolve the caoutchouc, but simply softens it and renders it capable of being more readily vulcanized. Alcohol also precipitates solutions of caoutchouc. When caoutchouc is treated with hot naphtha distilled from native petroleum or coal tar, it swells to thirty times its former bulk; and if then triturated with a pestle and pressed through a sieve, it affords a homogeneous varnish, the same that is used in preparing the patent water-proof cloth of Mackintosh. Caoutchouc dissolves in the fixed oils, such as linseed oil, but the varnish has not the property of becoming concrete on exposure to the air. Caoutchouc melts at a heat of about 256° or 260° after it has been melted, it does not solidify on cooling, but forms a sticky mass which does not become solid even when exposed to the air for months. Owing to this property, it furnishes a valuable material for the lubrication of stop-cocks and joints intended to remain air-tight and yet be movable.

CARBON CELLS AND PLATES FOR GALVANIC BATTERIES.

WITH a syrup made of equal quantities of lump sugar and water, mix wood-charcoal in powder with about a sixth part of a light powder sold by colormen, called vegetable black. The mixture should hang thickly on any mold dipped into it, and yet be sufficiently fluid to form itself into a smooth surface. The vegetable black considerably helps in this respect.

Molds of the cells required are made of stiff paper, and secured by wax or shellac. A projection should be made on the top of the mold for a connecting-piece. These molds are dipped into the carbon syrup, so as to cover the outside only, and then allowed to dry. This dipping and drying is repeated until the cells are sufficiently thick. When well dried they are then buried in sand, and baked in an oven sufficiently hot to destroy the paper mold. When cleared from the sand and burnt paper, the cells are soaked for some hours in dilute hydrochloric acid, and again well dried; then soaked in sugar syrup. When dry, they are then packed with sand in an iron box, gradually raised to a white heat, and left to cool. Should some of the cells be cracked, they need not be rejected, but covered with paper or plaster, and dipped in melted paraffin.

Rods or plates of carbon can be rolled or pressed out of a similar composition, but made thicker. Carbon thus made will be found to have a good metallic ring and a brilliant fracture. (47)

PROTECTING CAST-IRON PIPES.

THE water from mines frequently contains enough acid to attack cast-iron pipes, destroying them in a short time. Oil colors and varnishes offer but a limited resistance, and the process of enameling employed in Oberschlesia, says M. Englehardt, of Ibbenburen, although permanent and effective, is expensive. Cement is cheaper, and is not acted upon by these waters, and the only question to be settled was whether it would adhere to the smooth iron with sufficient firmness.

Two similar pieces of rolled iron were taken, and one of them painted over five times with a very thin cement, so that the coating was 0.15 or 0.20 of an inch thick. Both pieces were suspended near together in that part of the shaft where the water had attacked the signal cable most violently, and were left there four months. On taking them out, the unprotected iron was found to be reduced to one-third its original thickness: the other, in which a hole had been bored to suspend it, had suffered the same

corrosion at the exposed portion; the cement covering was dark brown, but perfectly hard and unattacked by the acid. The cement was broken off, and the surface of the iron exhibited the dark blue color and lustre that it had on leaving the rolls.

As this coating adhered so well to the smooth rolled iron, to which it can not cling as tightly as to the rougher surface of cast-iron, the experiment was continued on a larger scale. A 24-inch discharge-pipe in the Oeyhausen shaft was protected on the inside with cement. The coating remained unchanged for two years, while the pump was in constant operation. At the beginning of last winter the pump was stopped; and the pipe being no longer under water, the cement was so much injured by the frost that it scaled off. Several other experiments were made with similar results.

The pipes should be new, or, if old, well cleaned from rust before applying the cement, which is mixed as thin as is possible without injury to its tenacity. The pipe is moistened before the cement is applied, a thin coating of cement is put on and allowed to dry; when hard, it is moistened and a second coating applied, and so on four or five times. The operation can not be conducted so well in very hot weather, as the cement dries too quickly; nor must the pipes be exposed to frost during the operation or afterward. This unfortunate sensitiveness to cold may, perhaps, yet be overcome by intervening some semi-elastic material between the iron and cement.

TEMPERING STEEL AND REVIVING BURNT IRON.

THIS has been achieved very simply by H. Caron, by heating the water into which the steel at a red heat was plunged. A temperature of about 55° Centigrade has been found sufficient to give to needle-gun springs an elasticity and resistance equal to the best of those produced by the double process.

The temperature of the water should be varied according to the size of the piece of metal to be operated upon, and this temperature should be determined by preparatory trials. Tempering in very hot or boiling water affects in a very remarkable manner soft steel, containing, say, from two to four millionths of carbon—it increases its tenacity and elasticity without sensibly altering its softness—the grain seems to change its nature somewhat, and to become more granular or crystalline than it was previously.

The method then employed for reviving burnt iron is in like manner a bath in a hot liquid; and the citation of a single instance will probably be sufficient to enable the effects produced to be appreciated and verified if desired.

A bar of iron (Berry) three centimetres (1.181 inch) in diameter, which could be sent back upon itself when cold, without breaking, split, or fissure, got burnt; that is to say, was heated in such a manner that, placed in a vice, it was broken cold without any visible bending. The fracture was marked with a number of visible facets of several millimetres (0.039 inch) square. Close by, a boiling solution saturated with ordinary sea salt had been prepared, and a portion of the burnt bar, raised to a red heat, was plunged into this liquid and retained there during the time necessary to bring down the temperature of the metal to that of the bath—say, about boiling point. A somewhat singular phenomenon took place. No sooner was the red-hot iron plunged into the bath than it was covered with a coating of the salt, which isolated it from the liquid, and unquestionably lengthened the time it took in cooling. The piece of iron thus tempered was capable of being bent back on itself, as had been the bar prior to its being burnt. Thus, then, tempering in salt water will revive burnt iron.

It seems desirable, then, that all pieces of finished forging should be submitted to this process. If well wrought, the tempering will do them no harm. On the other hand, if they have been subjected to too great or too prolonged a heat, it will give to them those qualities which result from really good forging; and the same may be said of steel.

Without doubt there are other liquids and other solutions which would produce the same effects as this saline bath; but it has been selected for mention, because it is not only the most economical, but the one easiest to procure.

ENAMELING CAST-IRON.

AFTER heating cast-iron articles to a red heat in sand, and keeping them thus for half an hour, they are allowed to cool slowly, and are then carefully cleaned with hot diluted sulphuric or hydrochloric acid, rinsed with water and dried. A ground is then laid on by coating them with the following mixture, consisting of 6 parts of flint glass, 3 of borax, 1 of minium, 1 of oxide of zinc, mixed and finely pulverized, and heated for four hours up to a red heat, and finally rendered semi-fluid by increase of temperature; the mass is then quickly quenched in cold water, and one part of it is mixed with two parts of bone meal, and formed into a pap by triturating finely with sufficient water. Upon this, when dry, the two following mixtures, prepared like the first, are then laid in succession, the first of 32 parts of calcined bones, 16 of kaolin, 14 of felspar, 4 of

potash stirred up with water, dried, calcined, and suddenly cooled in water, and the powdered mass triturated with water to a fine paste with 16 parts of flint glass, 5½ of calcined bones, and 3 of calcined quartz ; after this has been laid on and well dried, a second coating is laid on of 4 parts of felspar, 4 of pure sand, 4 of potash, 6 of borax, 1 of oxide of zinc, 1 of saltpetre, 1 of white arsenic, and 1 of the best chalk; these ingredients are mixed, calcined, suddenly cooled in water, and triturated with 5½ parts of calcined bones, and 3 of quartz. The coated article is finally heated in a muffle in a furnace similar to a porcelain furnace, when both coatings fuse and mix, thus forming a very adhesive, white, and brilliant enamel.

SOLDERING IRON AND STEEL.

FOR large and heavy pieces of iron and steel, copper or brass is used. The surfaces to be united are first filed off, in order that they may be clean ; they are then bound together with steel, and upon the joint a thin strip of sheet copper or brass is laid, or, if necessary, fastened to it with a wire. The part to be soldered is now covered with a paste of clay, free from sand, to the thickness of one inch, the coating being applied to the width of a hand on each side of the piece. It is then laid near a fire, so that the clay may dry slowly. The part to be soldered is then held before the blast, and heated to a white heat, whereby the clay vitrifies. If iron is soldered to iron, the piece must be cooled off in water. In soldering steel to steel, however, the piece is allowed to cool slowly. The semi-vitrified clay is then knocked off, and the surface is cleaned in a proper manner. By following the hints given, it will be found that a durable and clean soldering is obtained. If brass instead of copper is used, it is not necessary to heat so strongly ; the former recommends itself, therefore, for steel. Articles of iron and steel of medium size are best united with hard or soft brass solder. In both cases the seams are cleanly filed and spread over with solder and borax, when the soldering seam is heated. Hard brass solder is prepared by melting in a crucible eight parts of brass, and adding one part of previously heated zinc. The crucible is then covered and exposed to a glowing heat for a few minutes, then emptied into a pail with cold water, the water being strongly agitated with a broom. Thus the metal is obtained in small grains or granules. Soft brass solder is obtained by melting together six parts of brass, one of zinc, and one of tin. The granulation is carried out as indicated above. Small articles are best soldered with hard silver solder or soft solder. The former is obtained by alloying equal parts of fine silver and

soft brass. In fusing, the mass is covered with borax, and, when cold, the metal is beaten out to a thin sheet, of which a sufficiently large and previously annealed piece is placed with borax upon the seams to be united and heated. Soft silver solder differs from hard silver solder only in that the former contains one-sixteenth of tin, which is added to it during fusion. Very fine articles of iron and steel are soldered with gold, namely, either with pure gold or hard gold solder. The latter can be obtained by fusion of one part gold, two parts silver, and three copper. Fine steel wire can also be soldered with tin, but the work is not very durable. Hard and soft brass solder are used for uniting copper and brass to iron and steel, silver solder for silver, hard gold solder for gold.

COVERING IRON WITH ZINC.

THE articles are immersed in very dilute sulphuric acid, and then washed in pure water; they are then allowed to remain for fourteen days in lime-water, to which dilute sulphuric acid is added from time to time. The iron articles are then immersed in a solution of zinc chloride (prepared by dissolving zinc in hydrochloric acid), to which $\frac{1}{10}$th per cent of ammonium chloride has been added. A thin coating of zinc soon forms upon the iron. The articles are then dried and immersed in molten zinc, until they attain the same temperature as the latter, when they are removed, hammered to remove excess of zinc, and left to cool. (90)

IMPROVED IRON AND STEEL.

BY adding from one to five per cent of an alloy of 10 parts tungsten and 90 parts chromium to iron and steel, special hardness and power of resisting rust are conferred upon these metals. A material of the color of silver, capable of high polish, and applicable as speculum metal, is obtained by fusing together 67 parts steel, and 33 parts of the tungsten-chromium alloy, which consists of 5 per cent tungsten and 95 per cent chromium. (36)

HARDENING STEEL.—It is not generally known that steel can be made so hard that it will pierce any known substance but a diamond. Many jewelers and lapidaries have great trouble in getting the points of their drills hard enough to pierce an amethyst. For the benefit of miners and others using drills that require a hard point, the following manner of manipulation may be recommended. The drills should be held, if small, by hot pincers or tongs, while tempering. First heat the tool to a white heat, and then press it into a stick of sealing-wax; leave it but a second there, and then stick it into the wax

in another place. This operation is rapidly repeated until the graver is too cool to enter the wax. In turning or drilling, the tool should be moistened with oil of turpentine.

WELDING OF COPPER.—P. Rust employs a mixture composed of 358 parts of phosphate of soda, and 124 parts of boracic acid. The powder is to be applied when the metal is at a dull red heat; it is then brought to a cherry-red and at once hammered. As the metal is very apt to soften when exposed to a high degree of heat, a wooden hammer is recommended. All carbonaceous matters are to be carefully removed from the surfaces to be joined, since the success of the operation depends on the formation of a very fusible phosphate of copper, which would be reduced by the carbon to the state of a phosphate. The phosphate of copper dissolves a thin film of oxide on the surfaces of the metal, keeping these clean and in a condition to weld. (143)

WELDING COPPER.—Rehbens, Roberts & Brocchus patent the following process, in which there seems to be but little novelty: The two pieces of copper to be united having previously been shaped so that the surfaces form a lap or other suitable joint, prepared borax (biborate of soda) is applied on and between the surfaces of the joint, which are heated and hammered. The borax is prepared by being heated until all the water of crystallization has evaporated, when the residuum is pulverized for use. After being hammered while hot, the joint is further heated to a white heat, and sprinkled over with the chloride, such as magnesic, sodic (common salt), or other equivalent compound, suitable for the exclusion of the oxygen, and then finally welded; or during the welding operation a stream of chlorine gas may be directed upon the heated copper joint.

EXTRACTION AND REFINING OF COPPER.—A. Gallico patents the following process: The ore is ground and watered with salt water, then roasted, afterwards watered again with salt water, then exposed in basins, in which the material is lixiviated with salt water and sulphuric acid. The material, being reduced to the consistency of a thick liquid, is passed through a succession of basins, filtered, and eventually compressed and dried.

CASTINGS.—A means highly recommended for obtaining very smooth castings, is mixing with the green foundry sand forming the mold about one-twentieth part of tar, a mixture which is employed without the addition of any other substance,

CHINESE AND JAPANESE BRONZES.

SOME bronzes exhibited in the Palais de l'Industrie attracted especial attention, not only on account of the beauty of the filigree and overlaid work, but also on account of the unusually deep bronze color (*patine foncée*), which in many specimens presented a beautiful dead-black appearance. The color, which was doubtless intended to contrast with the silver of the filigree work, was proved to belong to the substance proper of the bronze, and not to have been artificially produced by the application of sulphur to the exterior.

Analysis of different specimens of the bronze, by H. Morin, gave the following results:

	Tin.	Cop.	L'd.	Iron.	Zinc.	Arsenic.	
I.....	4.36	82.72	9.9	0.55	1.86	—	= 99.39
II.....	5.52	72.09	20.31	1.73	0.67	traces.	= 100.32
III	7.27	72.32	14.59	0.28	6.00	—	= 100.46

The alloy contains a much larger proportion of lead than is found in ordinary bronze; and it is noticeable that the quantity of lead augments precisely with the intensity of the bronze color, proving, as before stated, that the latter is due to the special composition of the bronze.

Some of the specimens contain a considerable proportion of zinc, but the presence of this metal, instead of improving the appearance, seemed rather to counterbalance the effect of the lead.

In imitation of the Chinese bronze, some alloys were made of the following composition:

	Tin.	Copper.	Lead.	Iron.	Zinc.
I.....	5.5	7.25	20.0	1.5	0.5
II.....	5.0	83.0	10.0	—	2.0

No. 1 produced an alloy exceedingly difficult to work, and, without giving any superior results as regards color, furnished castings which were extremely brittle.

No. 2, on the contrary, gave an alloy exactly resembling the Chinese bronze. Its fracture and polish were identical, and when heated in a muffle, it quickly assumed the peculiar dead-black appearance which was so greatly admired in the Chinese specimens.

Hitherto it has been found difficult, if not impossible, to obtain this depth of color with bronzes of modern art, since the surface scales off when heated under similar conditions. (4)

ALUMINIUM SILVER.—The following alloy takes a high polish, and exhibits a beautiful silvery color:

Copper.....	70
Nickel.....	23
Aluminium.....	7
	100

MICA.

THIS mineral is sometimes erroneously called "isinglass," "Muscovy glass," etc. Its name signifies to shine, to glitter, from this conspicuous characteristic which it possesses; it is of common occurrence in primary and secondary formations; is one of the chief constituents of granite, mica schist, and to a small extent gneiss. In limestone it forms masses, pockets, beds, and veins, often of considerable size. In granite the plates or crystals are small, mostly under an inch in diameter, though in some coarse granitic formations a foot and upward. In Siberia plates have been met with as much as 5 feet and 7 feet across.

The group of micas may be classified in two divisions. Those which are silicates of alumina and alkalines, as muscovite, lepidolite, and the magnesian micas, as phlogopite, biotite, etc. All are readily distinguishable for their brilliant lustre or glitter, whence the name, as well as for their distinct cleavage in one direction, and tough foliaceous structure, which permits of separation into very thin sheets. The two species described below are very valuable in commerce. Muscovite is essentially a silicate of alumina and potash, with occasionally a small and varying quantity of iron, traces of fluorine, and in some of the green varieties chromium; crystallization, trimetric, usually six-sided tables; color, black, brown, silvery white, gray, green, with pearly, pseudo-metallic lustre; not attacked by acids; refractory, only fusing on thin edges before the blow-pipe; lamine very tough and flexible.

Phlogopite: Magnesian mica; composition silica, alumina, and magnesia, with traces of iron, potash, with soda and fluorine; crystallization similar to the foregoing: color, brown, reddish-brown, yellowish-brown, olive-green, gray with pearly lustre: whitens in blow-pipe flame and melts on thin edges; when reduced to a fine powder, attacked by hot sulphuric acid, the silica separating in thin scales; also like muscovite, so tough and elastic that it can be split into sheets of extreme tenuity. This species is mostly found in limestone.

The early history of mica and its uses are obscure. But the researches of Professor Kerr in North Carolina have brought to light very ancient, and probably the remains of the most extensive, mica mines that are known in any country. These operations were invariably in ledges of coarse granite, which contain nothing but patches of mica. The size and number of these mines are said to be remarkable; some of the open cuts are 100 feet in diameter and 80 feet deep. Tunnels also of considerable

length exist, though too small to permit an ordinary-sized man to work in, but showing distinct marks of a chisel-shaped tool about an inch in breadth in the granite wall. A quantity of mica plates have been found in these works; some, trimmed to particular shapes, have led to the conjecture that the uses to which it was applied were for windows, mirrors, ornaments, etc. The magnitude of the operations excites surprise, and shows that a large demand must have then existed.

In more modern times the use of mica was chiefly for windows of war-ships, lanterns, and other conditions liable to concussion; but recently it has been applied to a variety of useful purposes, and has acquired a very considerable value, so that in times of scarcity good qualities have sold as high as 10 dollars, 15 dollars, and even more per pound. The value of mica is determined by the color, size, soundness, and toughness; the most transparent large sound sheets being in highest esteem. The chief consumption at present is for stove glass. Without mica we should lack the cosy, ruddy, genial glow of the base-burning and other illuminated stoves. The quantity consumed annually in this branch it is difficult to ascertain, but it is necessarily very large. Coarsely pulverized, it is found to be an excellent roofing material (far superior to ordinary gravel), to which use it is also applied in the same manner as slate. It makes, when finely ground, a good lubricant for certain purposes. It is superior to cardboard for marine compass dials. Formerly it was largely used as a filling for fire-proof safes. It is also used in the lettering of fancy signs. When very clear it forms a better protection to photographs than enamel. But by far the most artistic application is in the manufacture of lamp-shades. With the aid of chromo-lithography exquisite pictures are printed on sheets of mica, three or four of which are tastefully joined together, and form a really beautiful design. Mica is eagerly sought for to supply the large and increasing demand. Active operations are carried on in various places, particularly in North-Carolina, New-Jersey, etc.; also in several places in Canada. (142)

BLEACHING ANIMAL GLUE.—A. Muzzarelli adds to fine white glue prepared from rabbit skins for dressing white tissues, a small quantity of sulphate of soda, and well mixes; acetate of lead is then added, whereby a precipitate of sulphate of lead is occasioned; the resulting jelly is thus blanched, and, after cooling, is cut up and dried as usual. (21)

PRODUCTION OF PATINA ON BRONZE.—Christofle and Bouilhet state that lead is not essential to the production of a fine black patina, and its presence is objectionable, as it renders the bronze brittle. By means of appropriate reagents a patina of very variable color can be produced; thus, silver goods can be produced with the natural color bright or dead; with a fine black violet, patina produced by chlorination; and with a fine black brown, patina obtained by sulphurization. Gold can be deadened by a slight sulphurization. Bronze can be covered with a red, black, brown, or green patina by suitable oxidization or sulphurization.

TO MAKE IMITATION GOLD.—Take of pure copper, 100 parts; zinc or preferable tin, 17 parts; magnesia, 6 parts; sal-ammoniac, 3.6 parts; quicklime, 1.8 parts; tartar of commerce, 9 parts. The copper is first melted, then the magnesia, sal-ammoniac, lime, and tartar are added separately and by degrees, in the form of powder; the whole is now briskly stirred for about half an hour, so as to mix thoroughly; and the zinc is added in small grains, by throwing it on the surface and stirring until it is entirely fused: the crucible is then covered, and the fusion maintained for about 35 minutes. The surface is afterwards skimmed, and the alloy is ready for casting. It has a fine grain, is malleable, and takes a splendid polish. It does not corrode readily, and for many purposes is an excellent substitute for gold. When tarnished, its brilliancy can be restored by a little acidulated water.

TO DETECT METALLIC MERCURY IN COMMERCIAL CINNABAR (VERMILION).—K. Heumann rubbed the samples with water upon bright sheet-copper, in the opinion that free mercury would be detected by the appearance of amalgamation. As the copper became amalgamated in every case, while no mercury was dissolved out of the samples by dilute nitric acid, it became apparent that copper is capable of decomposing cinnabar. On boiling cinnabar in water with powdered copper, the red color of the mixture disappears, and is succeeded by a black gray from the production of sulphide of copper. Powdered zinc had a more energetic action, though here also the sublimed variety appeared more stable than that formed in the moist way.

IVORY-PAPER.—Koller mentions under this name a kind of glazed cardboard which permits the easy rubbing out of pencil and even ink marks, provided these latter are not allowed to remain too long on it. No description is given as to its mode of preparation, or as to the ingredients used. Its use by school children in the place of slates is very strongly recommended.

NEW WELDING COMPOUND.

So many difficulties surround the process of welding iron or steel, that inventors have long essayed to originate some plan by which the desired union could be more perfectly accomplished. Both pieces of the material intended to be joined have had to be heated to such a degree as frequently to impair their value for after use. If there is a chemical difference between the two pieces, the assimilation of the point of contact is not perfect under the ordinary method of welding, and a fracture at that point is more likely than at any other place; besides, under such conditions, the welding shows so plainly as to mar the appearance of the finished work. In order to facilitate the welding process, borax is commonly used. Singly, or in combination with other materials, it is a most valuable agent in promoting the welding of metals, but a recent discovery has resulted in the introduction of a welding compound which is altogether unequaled in its practical efficacy. This compound consists of calcined borax mixed in proper proportions with wrought-iron reduced by grinding or other means to particles a little larger than coarse filings. The effects of the use of this almost magical powder are easily described. The pieces of metal intended to be welded are heated only to a cherry-red, then a small quantity of the compound is sprinkled over the heated end of each piece, the ends are placed in contact, the hammer does its share of the work, and the union thus accomplished is so perfect that no steam-hammer can effect a fracture at the same place, and, when polished, the eye can not possibly detect the line which should mark the junction. Whether cast-steel and cast-iron, cast-steel and wrought-iron, cast-iron and cast-iron, cast-iron and wrought-iron is desired to be welded, the union in each case is equally close, and the results are uniform. All of them can be welded so perfectly that the heart of the blacksmith and of the machinist rejoices at the ease of this operation. Rolled metals can be treated in the same manner. At the Delamater Works, and at the manufactory of the fire and burglar-proof safes of Messrs. Terwilliger & Co., New-York (who declare in a published testimonial that it surpasses the best welding material they have ever tried), it is used for uniting iron and steel plates, so as to give to an iron plate a coating of steel on one or both sides, while the result is such an intimate union that it is utterly impossible to distinguish with the naked eye that the plate is not one homogeneous piece. The rolling takes place, as stated, at a low cherry-red, which has been found to produce a saving in fuel of 20

per cent, and a saving in material, as the unavoidable loss of weight in the iron by the formation of scale, so considerable at a high temperature, is reduced some seventy per cent, or even more. Iron rails can be provided with steel heads so perfectly welded that they can not be separated even at the ends, and old rails can be rerolled with it as perfectly as if they were soft iron, and at a heat but little above that to which iron must be brought for the rolls.

SOLDERING IRON AND STEEL.

FOR large pieces of iron or steel, Fr. Sieburger uses copper or brass as solder. The plates to be soldered are bound together with wire, a thin layer of copper or brass placed along the junction, and the whole covered with a layer, 1 inch in thickness, of clay free from sand. After drying, the plates are brought to a white heat, and then plunged into cold water, in the case of iron being soldered to iron; or allowed slowly to cool if iron be soldered to steel, or steel to steel. The vitrified clay is then broken off.

For smaller articles, the author prepares a solder by granulating a mixture of 8 parts of brass with 1 part of zinc; this solder is mixed with borax, and spread over the articles to be joined.

For very small articles, a solder prepared by fusing together 6 parts of brass, 1 part of zinc, and 1 of tin is used. The solder is beaten into thin plates, which are applied together with borax to the surfaces of the articles to be soldered.

Very small and delicate articles are best soldered by gold, which may be either pure or mixed with 2 parts of silver and 3 of copper.

CUTTING STEEL RAILS COLD.

THE cutting of a file in halves with soft iron was an old lecture experiment. The soft iron formed a disc about 6 inches in diameter mounted on a lathe spindle, and run at about 2,000 revolutions per minute. A file held to the edge of the disc was cut in two in about ten or fifteen seconds, the disc being unharmed. The shower of sparks rendered this a brilliant experiment, very popular with a general audience. The principle involved is now being applied to a practical purpose. Mr. Charles White, Manager, Sir J. Brown and Co.'s Works, Sheffield, has found the cost of cutting off the ends of steel rails cold, in the ordinary way, so enormous that he resolved to try another expedient. For experiment, he had an ordinary rail-saw put in the lathe and all the teeth cut off. The revolving disc was then mounted on a spindle and driven at nearly 3,000

revolutions a minute. The disc was 3 feet in diameter, so that its circumferential velocity was about 27,000 feet, or over five miles a minute, or 300 miles an hour. Steel rails forced against the edge of this disc were easily cut through in three or four minutes each. The rails weighed 65 lbs. to the yard. Sparks flew in abundance, and the disc appeared to melt the rail before it; but after cutting five rails the disc itself was not sensibly warm. The experiment was such a complete success that the firm intend putting up a very powerful saw for the purpose of cutting cold steel rails. (611)

UTILIZATION OF SLAG.

A METHOD of utilizing slag, in use at the blast furnaces at Osnabrück, in Hanover, is to allow it to fall in a stream from a height of about eight feet into tank water. It is thus granulated into particles of the size of a bean. From the water it is lifted by an elevator into cars and conveyed away, to be used in ballasting the roads and railways.

COPPERING OF IRON ROLLERS FOR CALICO PRINTING.

TH. SCHLUMBERGER cleanses the iron cylinders with a concentrated alkaline lye, washes well in water, and goes over the whole surface with the file. The surface is then very bright, and is not to be touched with the finger or soiled with the breath. It is then plunged into an alkaline bath composed of sulphate of copper, 1 part, dissolved in water, 12 parts; cyanide of potassium, 3 parts; carbonate of soda, 4 parts; sulphate of soda, 2 parts, dissolved in water, 16 parts. Or, ammonia, 3 parts, acetate of copper, 2 parts, dissolved in water, 10 parts; cyanide of potassium, 3 parts, carbonate of soda, 4 parts, sulphate of soda, 2 parts, dissolved in water, 10 parts. The cylinder is allowed to remain twenty-four hours in one of these baths, subject to the action of a battery of four or six pairs, till the surface is coated with a slender but adherent layer of copper. It is washed and cleansed with pumice-stone. If in this operation the iron should be laid bare in any part, the cylinder must be anew submitted to the alkaline bath. As soon as the coating of copper is uniform, it is washed in acidulated water and immersed in an acid bath of sulphate of copper. This bath is composed of solution of copper at 20° B., to which $\frac{1}{100}$ of its volume of sulphuric acid is added, to facilitate the solution of some metallic copper, which is also immersed in the bath for the purpose of maintaining the solution in a uniform state of concentration. Here the cylinder is left till the layer of copper has attained the desired thickness, a galvanic current being kept up by a battery of four pairs. If the temperature is between 60° and

65°, three to four weeks are required to produce a deposit of one thirty-third of an inch in thickness. The cylinder is turned one-quarter round daily, to change the portion of its surface which faces the sheet of copper used as a positive electrode.

ZINC A PREVENTIVE OF BOILER INCRUSTATION.

AN engineer on board the "St. Laurent," a steamer plying between this port and France, after making some repairs in the boilers, left accidentally therein an ingot of zinc. Some time after, in searching for the bar in the generator, in which, meanwhile, steam had been maintained, he found to his surprise that the metal had disappeared, and also that the incrustation left by the water, instead of being hard and firm, was a mere mud, easily washed out. Repeating the experiment over another voyage, the same result was reached. M. Lesueur, of Angers, France, after examining into this circumstance, thinks that the zinc forms a voltaic couple with the iron of the boiler, zinc being the negative pole and the iron the positive. It then happens, as in all batteries, that the zinc is consumed; while the iron is protected both from oxidation and dissolution.

TO POLISH GOLD AND SILVER LACE.

ONE and a half ounce of shellac, half a drachm of dragon's blood, and half a drachm of tumeric root, are treated with strong alcohol, and the ruby-red colored solution is decanted. The objects to be restored or brightened (either gold lace, spangles, clasps, or knobs) are then brushed over with some of the color by a camel's-hair brush, and then a hot flat-iron is passed over, so that the objects shall only be gently warmed. Gold embroidery is treated in the same manner. Detached gold knobs are fastened on a stand, brushed over with the gold lace, and then dried over red-hot coals, with the before-mentioned precautions. Silver lace or embroidery is polished with a powder obtained as follows: Alabaster is strongly ignited, and then while hot is placed in corn brandy. A white powder is obtained, which is gently ignited over the flame of a spirit-lamp. The powder is placed in a linen bag, and the lace, etc., is dusted over with it, and then brushed over.

SUBSTITUTE FOR TIN-FOIL.

COMMERCIAL zinc-dust is rubbed up with egg-albumin to a thin mass, and applied by means of a brush or roller to linen and cotton goods. When dry, the albumin is coagulated by steam, and the goods are immersed in a solution of tin chloride. The tin is deposited in a finely divided

state upon the zinc. By burnishing the whole or part, very pretty effects may be produced. Linen, etc., prepared in this way, is a good (and water-proof) substitute for tin-foil in many cases. (90)

RESHARPENING FILES.

WELL-WORN files are first carefully cleaned with hot water and soda; they are then placed in connection with the positive pole of a battery, in a bath composed of 40 parts of sulphuric acid and 1,000 parts of water. The negative is formed of a copper spiral, surrounding the files but not touching them; the coil terminates in a wire which rises toward the surface. This arrangement is the result of practical experience. When the files have been in the bath ten minutes, they are taken out, washed and dried, when the whole of the hollows will be found to have been attacked in a very sensible manner; but should the effect not be sufficient, they are replaced in the bath for the same period as before. Sometimes two operations are necessary, but seldom more. The files, thus treated, are to all appearances like new ones, and are said to be good for 60 hours' work. M. Werdermann employs twelve medium Bunsen elements for his batteries.

ALLOY FOR COATING MIRRORS WITH AN ALLOY OF GOLD AND PLATINUM.—A solution of 500 grammes of spongy platinum in 100 cc. of a mixture of equal parts of hydrochloric and nitric acids is evaporated to dryness, and the dry residue after powdering digested with 2,000 grammes of lavender essence, 100 grammes of turpentine, and 25 grammes of sulphureted turpentine resins. The gold, 30 grammes, is transformed into chloride, and this dissolved in 1,000 cc. of a mixture of equal parts of water and ether. The mixture is well shaken, and ethereal solution added to the platinum, and left to evaporate spontaneously. The mixture receives afterward a charge of 50 grammes of litharge and a like quantity of lead borate, and 100 grammes of lavender oil are added to it, when it will be ready for coating the mirror, which has to be exposed to red heat until the composition is burnt in. (36)

GALENITE.—J. David patents the manufacture of a new compound of lead, applicable to the purposes for which white-lead and red-lead are employed, and producing such compound from galena. In this invention galena is reduced to powder, and is oxidized at a low red heat in open retorts and thus converted into a basic sulphate, which is then ground between millstones immersed in water. The liquid thus obtained is placed in vats; and

the suspended matter is allowed to deposit, and is dried, constituting a new substance termed "galenite," which is applicable to all purposes for which red-lead and white-lead are employed.

EXTRACTION OF GOLD BY CHLORINE.

Plattner's Method.—By passing dry chlorine over the slightly moistened ore, the gold can be dissolved out as chloride. The ore must be as free as possible from sulphur, antimony, arsenic, and iron (oxide of iron, however, does no harm), since these metals precipitate the gold and cause more or less loss. When the process is carefully conducted, 97 per cent of the gold can be obtained.

UNALTERABLE ALLOY.—Jacobi patents the use of the following alloy, which possesses a yellowish red tint and may be used for objects of art, imitation jewelry, etc.

Copper	70 to 73 per cent.
Tin	2 to 11 "
Lead	15 to 20 "
Zinc	0.5 to 1 "

When treated with polysulphides, chloride of antimony, chloride of arsenic, etc., this alloy becomes coated with a black patina capable of being polished.

GLAZING FOR COMMON EARTHENWARE.

WATER-GLASS (potassium or sodium silicate) of 35° Baumé, either alone or with the addition of 20 per cent of red lead, and 5 per cent silicic acid, is used. The thick solution is laid upon the half-burnt ware by means of a brush. This glaze can be used for statuettes and other ornamental objects of like nature. It is also useful for glazing crockery, being quite indestructible when well burnt.

USE OF SILICATE OF SODA FOR CEMENTS.—Soluble glass mixed with powdered chalk furnishes a mortar hardening completely in six to eight hours; mixed with antimony sulphide it forms a dark mass, susceptible of a high polish; with iron filings a grayish-black, very hard mass results, whilst with zinc filings a very hard gray metallic mass is produced, which serves well to cement together zinc work.

SODIUM WIRE.—A. W. Hofmann prepares sodium in the form of wire by means of a brass cylinder furnished with a piston moved by a screw, and provided at the other end with a delivery plate pierced by a hole of suitable diameter; the cylinder is arranged vertically, the lower end dipping into a vessel containing petroleum to prevent oxidation of the metal wire; on turning the screw, the soft metal is "squirted" out as wire.

TEST PAPERS.

FOR the preparation of litmus paper, F. Mohr recommends that the litmus be washed with hot alcohol, and then extracted with cold water. This extract may be brushed on writing-paper on one side. The paper must be washed with water to remove free alkali or acid.

Tumeric roots contain two yellow dyes, one soluble in water and unaffected by alkalies, the other soluble in alcohol. The roots should be washed in water as long as the washings are colored, and then exhausted with alcohol.

Paper soaked in potassium sulphocyanate or ferrocyanide may be used for the detection of iron.

Paper containing starch moistened with a solution of potassium iodate in oxalic acid, and dried, is turned blue by bodies which act as reducing agents, such as sulphurous acid, hyposulphites, sulphureted hydrogen, potassium sulphocyanate, ferrous oxide, cupric chloride, potassium iodide, and similar bodies.

For oxidizing bodies a starch paper with potassium iodide may be used. To keep such paper unchanged, a lighted sulphur-match should be held in the bottle in which the paper is preserved before closing the stopper.

The author also recommends the following test-papers: For ammonia-gas: paper soaked in mercurous oxide solution. For sulphureted hydrogen and alkaline sulphides: acetate of lead paper; filter-paper soaked in cobalt chloride; polished visiting-cards, known as "Polka papier;" paper painted with bismuth white.

For metals which give black precipitates with sulphureted hydrogen in acid solution, washed sulphide of zinc precipitated from the acetate is smeared on writing-paper and dried. Any mineral acid decomposes the sulphide of zinc, setting free sulphureted hydrogen, which immediately precipitates the metals present.

FIXING OF PRINTED LABELS ON MACHINES, ETC.—Labels are often required to be affixed to parts of machines; but the paste, etc., used for this purpose often becomes damp, and the labels fall off. A paste or mucilage to resist damp may be made as follows: Prepare a paste of good rye flour and glue, to which linseed-oil varnish and turpentine have been added, in the proportion of half an ounce of each to the pound.

BUTTER.—D. Hipkins uses the following method of manufacturing artificial butter, and of clarifying or purifying rancid butter:

This consists (1) in making artificial butter by melting fat by means of steam or hot water. The fat is then

drawn off and allowed to cool. It is then raisen in temperature, and the oleine removed by pressure from the stearine. The oleine is then melted and suddenly cooled by plunging it into a liquid, and thus becomes very similar to butter; (2) in purifying rancid butter by melting it and removing any deposit: then boiling it with lime-water and allowing it to settle; and finally, treating the liquor thus clarified by suddenly cooling.

L. Chichkoff states that by agitating together milk (previously deprived of cream and warmed) and butter, an emulsion is formed, from which a kind of cream separates on standing, which is converted into butter by churning. Both this artificial butter and ordinary natural butter consist of milky globules or bubbles, the interstices of which are filled by a solution of caseine, sugar of milk, and salts. These bubbles remain fluid, even at low temperatures, but solidify by churning or the communication of an acid reaction to the liquid, a low temperature assisting. (22)

HOW THEY DROP SHOT.

ONE of the secrets of the manufacture is the mixing of the lead with a certain proportion of a combination of mineral substances called "temper." The "temper" is fused with the lead, and gives the molten metal that consistency which makes it drop. If it were not for the "temper," the lead would be molded by the sieve, and would form little pencils instead of round shot. When "BB" shot, for instance, are to be made, the lead is poured into a pan perforated with holes corresponding to that size. The little pellets come pouring down in a continuous shower, and fall into a tank filled with water on the ground floor. In their descent of two hundred feet they become perfect spheres, firm and dense, and they are tolerably cool when they strike the water, although the swift concussions make the tank foam and bubble as if the water was boiling furiously. The shot must fall in water, for if they should strike any firm substance they would be flattened and knocked out of shape. To get the little pellets perfectly dry after they have been in the well, is the most difficult and troublesome process of the whole manufacture. An elevator with small buckets (very much like those used in flour mills) carries the shot up, as fast as they reach the bottom of the well, and deposits them in a box sixty feet above the first floor. The water drips from the buckets as they go up, and not much is poured into the receiver above, although it is intended to be a sort of dripping machine. From this receiver the shot runs down a spout into a drying pan, which greatly resembles a gigantic

shoe, made of sheet-iron. The pan rests at an angle which permits the wet shot to roll slowly down to the chamber below, and the pellets become perfectly dry as they pass over the warm sheet-iron. (139)

EXPLOSIVES.—A. P. Blake proposes the use of an explosive compound consisting of nitro-glycerine washed with water, and a solution of silicate of soda, and mixed with other substances to dilute and modify its action. The substances used in place of infusorial earth are the scales of fresh-water fish mixed with carbonate of soda, and nitrate of soda, well-burned, ground, and sifted. Nitrate of soda, manganese, double carbonate of soda, and prepared sawdust are mixed with a solution of resin and spirits of wine. The mixture is mixed in a damp state with the prepared infusorial earth. After the second mixture is prepared, a third is made by sprinkling that already obtained with a solution of sulphur or bicarbonate of sulphur, and then by adding finely-ground burned bones or coal. This mixture is then further manipulated in other rooms. First, it is mixed with bran and prepared sawdust, which are saturated with nitro-glycerine. This is repeated with the hand until the requisite quantity of nitro-glycerine is absorbed. The explosive is formed into cartridges and carefully packed. Other modifications of this preparation are also made up and employed.

STEEL SWORDS.—Several swords, valued not only for their workmanship and temper, but for the circumstances under which the owner had become possessed of them, had been reduced by a fire to the condition apparently of twisted pieces of hoop iron. They were sent to Birmingham, and sometime afterward returned in a condition "differing but little from what they had been before their fiery ordeal." The swords had been hung upon the walls, and afterward, when disinterred from the ruins, were "mere crumpled bits of burnt and rusty iron." Messrs. Wilkinson say that it is often of great importance that the outer scale left by the fire should not be removed, nor any attempt at cleaning the surface be made, unless by experienced hands. In the case of sword blades especially, they find that the minutest details of embossed ornament can generally be traced over the outer scale of burnt steel, and may be copied and restored unless obliterated by friction. Inlaid or damascened gold-work on steel will stand a very high degree of heat without being destroyed, and the figure of the genuine Damascus blades, being a part of the structure of the metal, can be restored as long as any of the steel remains. (106)

ARTIFICIAL LEATHER.

XAVIER KARCHESKI, of Belleville, N. J., has invented the following new article of vegetable leather, which is composed of a web of paper having one or both of its surfaces converted into vegetable parchment, dyed by a process which produces an even and perfect diffusion of color throughout the material, and then embossed to imitate leather. Thus prepared, the vegetable leather may be used for book-bindings, for reticules, pocket-books, valises, etc.

The process is as follows: "I take paper of any desired thickness and immerse it in a weak solution of sulphuric acid, the thickness of the paper or the sizing upon the paper determining the strength of the acid solution. The object being to reduce only the surface of the paper to pulp without dissolving the entire fabric, so that the result will be a paper web retaining its fibrous quality, but inclosed within two films of vegetable parchment.

"After the surfaces of the paper have been reduced, by the action of the acid, to a pulpy state, it is withdrawn from the acid-bath and lightly scraped by being drawn over stationary scrapers for the purpose of removing the excess of acid, care being taken not to scrape hard enough to remove the pulp or tear the sheet. The sheet or web is then passed over a series of hard, smooth rollers, which compress and spread the pulp evenly over the surfaces of the web, thus producing a fabric smooth and glossy on both sides. The fabric is then submitted to a water-bath for the purpose of diluting and partially washing out the sulphuric acid in it, a small quantity of acid being allowed to remain. After removal from the water-bath the fabric is then submitted to a series of dye-baths, more or less in number, according to the depth of color required.

"The dyes are either alkaline or an alkali is added, if necessary. The sulphuric acid which I leave in the fabric acts as a mordant, and the energy and avidity with which the alkaline dyes seek the acid causes a uniform and complete diffusion of color throughout the fabric. The carbonates of alkali combine with the acid, forming sulphates which are not injurious. The fabric is then washed with water to remove any sulphates or excess of coloring matter lying upon its surfaces, and again drawn over the scrapers to remove the excess of water. It is then passed through a warm bath of glycerin or some other softening material, which, by reason of the water remaining in the fabric, penetrates it throughout. It is then carried to hot drying-cylinders, over which it is kept passing until the water has been completely expelled, care being had not to

subject it to a high enough heat to evaporate the softening material. The fabric is then passed through cold calender-rollers until it is thoroughly chilled, and, being then wound upon a reel, is ready for embossing. The embossing is effected in the usual manner by subjecting the fabric to hot pressure from engraved rolls.

"My design is to have the fabric as much the nature of leather as possible. For this reason I treat with acid only superficially, in order not to destroy the fibre in the centre of the fabric. Leather is composed of an albuminous insoluble surface, fibre, and epidermis, and paper treated by my process is composed, likewise, of an insoluble surface, fibre, and softening or gelatinous matter within it.

"When it is desired to convert only one surface of the paper into vegetable parchment, leaving the balance fibre, the process is modified by substituting in place of the acid-bath a roller or rollers of smooth lead or rubber revolving in acid, over which the paper is carried, and upon which it is compressed by another roller or rollers. By this means only one side of the paper absorbs the acid, the remainder of the process being the same as when both sides of the paper are converted into vegetable parchment."

A NEW invention by Carl Augresius, of New-York city, consists in making the sole of the boot hollow, to contain oil, with a lamp-wick extending to a combustion chamber in the heel. He says, by this arrangement persons exposed to cold temperatures and suffering from cold feet are enabled to keep their feet warm during all seasons of the year. The heating attachment can be applied to boots or shoes of any description.

NEW PORTABLE BOATS.—Extreme lightness, compactness, and indestructibility are all requisites looked for by the general tourist, sportsman, and trapper, in the selection of a boat. The boat invented and manufactured by Mr. John Hegeman, of Ballston Spa, N. Y., seems to us to fill all these most desirable points. Constructed of a strong folding frame of hickory or ash, secured by gun-metal fastenings, it can be quickly covered with a strong cotton duck canvas, which has been proved by thorough tests to have great strength, durability, and to be perfectly waterproof. When not in use, the cover may be taken off, the frame folded up and put anywhere, as the boat takes up hardly any bulk. Mr. Hegeman makes five different sizes, from 9 feet to 13 feet long, the first carrying conveniently one person, the latter from five to seven. The folding boat being a flat-bottomed one, allows it, from its slight draught of water, to carry three people, and it will not

draw more than an inch. Its buoyancy is further increased by cork fenders placed under the gunwale. Prices range from $75 to $117. A great many of these boats are now in use, and seem to have given perfect satisfaction.

Bonds' improved section boat, made at Cleveland, Ohio, has attracted a great deal of attention.

We hear of a new boat, to be built on a kind of lattice steel frame, which may offer some advantages. It is represented to be exceedingly light. (119)

SELF-LIGHTING SEA SIGNAL.

N. HOLMES describes the use of calcium phosphide for the production of a brilliant light as a danger signal at sea; phosphorus and chalk are heated together to a white heat; when brought in contact with water, spontaneously inflammable phosphoreted hydrogen is evolved, whilst the material itself is incombustible, and is perfectly safe for carriage. To utilize this for marine purposes, the material is hermetically sealed in a conical tin case, with a copper exit for the flame at the top, an entrance for the water at the bottom, and a tip of soft metal at the bottom and top of the cone. This conical case contains a perforated tube running down to the cone point, and closed by a soft metal tip. The inflammable phosphide of calcium is ranged all round this tube, and the whole apparatus will float like a buoy on water. To bring it into use, the soft metal tips are cut away with a knife which a sailor is never without, the case is thrown into the sea, the water ascends into the perforated tube, causes the phosphide of calcium to inflame, and the composition contained in a small case, say 4 inches by 6 inches, will give a fierce light for three-quarters of an hour, and will burn for about two hours.

CANADIAN ICE SIGNALS.—A very beautiful and useful system of ice-signaling has been recently adopted by one of the Canadian steamship lines, which promises to give great safety and security to passengers crossing the Atlantic. The company has issued to all its commanders an ice chart and tallying ice signals, by the use of which steamers passing each other can learn when and where dangerous bergs and ice-fields have been encountered. The ice chart is divided into degrees of longitude and half degrees of latitude, nearly making squares, each of which has a separate literal designation. This in each section of the chart consists of two letters, representing two flags of the commercial code, and when the corresponding flags are hoisted by a steamer they indicate to the passing ship the exact position of the ice met. The ensign hoisted

above the three, means berg ice, and the Union Jack, field ice likely to imperil navigation. The flags are, of course, only serviceable in the day time, but at night the ice signals are made by means of Colomb's Chatham lamp. The whole system is one of extreme simplicity, both in the chart and code, and easily enables any steamer, after passing through the ice track near Newfoundland, to communicate to the steamer approaching it the precise place of the peril, and, therefore, the imminent necessity of extreme caution in nearing that point.

NEW PROCESS FOR RENDERING GLASS HAIL AND FIRE PROOF.

THE *Salut Public* of Lyons gives an account of some experiments that have lately been made with a view to testing the value of a process invented by M. de la Bastie, a manufacturer of Bourg, for strengthening glass so as to render it not only hail-proof, but also to resist the effects of fire and accidents.

These experiments were carried out at the railway station of the Pont d'Ain at the request of the authorities of the railway company, in order to satisfy them of the value of this invention, which naturally would be of the highest importance to them, were it possible to render less liable to breakage the glass roofs, the repairs of which form a serious item in the expenditure of railway companies.

A sheet of glass 6 millimetres in thickness, held in a wooden frame, was placed on the floor of the room, and a brass ball weighing 100 grammes was let fall on it, from a height which was gradually increased until the glass was broken by the shock. It was found that falling from a height of 24 centimetres the glass was shattered by the ball.

A sheet of glass only half the thickness (namely, 3 millimetres), but which had been prepared by the new process, was then placed in the frame, and the same weight was allowed to fall upon it, gradually increasing the height, but without any effect even when dropped from the ceiling of the room.

The experiment was next continued out of doors, and it was not until the weight had been dropped from a height of 5.75 centimetres, that the plate of glass was broken. Dropped on the ground, a sheet of the prepared glass rebounded slightly, and with a sound similar to that of metal when thrown down.

Another experiment was made with a view to test its resistance to fire. A piece of common glass was held in the flame of a lamp, and at the end of 24 seconds it snapped in two. The same was repeated with a slip of the prepared glass, but the flame had no effect upon it; and

even after plunging the heated glass suddenly into cold water the glass was not broken. The importance of such an invention may easily be imagined, and its application in an endless variety of ways will readily suggest themselves, not only to engineers, builders, etc., but to persons engaged in almost every class of trade. The agent of M. Bastie lately exhibited specimens of glass at the office of the *Scientific American*, New-York, and subjected the same successfully to many of the remarkable tests above mentioned. The process of treating the glass has not yet been made public.

MANGANESE IN GLASS-MAKING.

MANGANESE imparts to glass a violet color, iron a grenish-yellow color. By giving up part of its oxygen to the iron, the manganese peroxide destroys the blue element of the greenish tint, and only the yellow is left, while at the same time, by the loss of oxygen, the violet of the manganese is weakened. But yellow is complementary to violet, since violet is composed of red and blue: hence the glass becomes colorless. This is easily proved by placing a yellow glass plate upon a violet one. Objects viewed through the two are seen in their natural colors. Bodies containing carbon act in the same way as iron protoxide; hence the manganese peroxide is not added to the glass till the other ingredients have been melted together, in order to avoid the action of the fuel, smoke, etc., upon it. When too much manganese peroxide has been added, it is only necessary to dip a wooden pole into the pot containing the melted glass, to remove the color. As a matter of fact, the manganese is always added in slight excess, because. in the processes of annealing, etc., some oxygen is lost. To fix the violet color, it is necessary to add some potassium or sodium nitrate to supply the loss of oxygen.

GLASS COLORED WITH GOLD.

THE color produced in glass by gold depends on the temperature to which the glass is subjected, and the material of the mold into which it is cast. Low temperatures produce a bluish color, or even render it colorless; on heating, a brilliant crimson is again produced.

PHOSPHORUS BRONZE.—Some of the brands will bear a considerably greater breaking strain than steel itself. It appears, also, to be suitable for sheathing ships, since, when immersed in sea water, it loses scarcely more than one-third as much as is lost by the best sheet copper.

THIN MICROSCOPIC GLASS COVERS.

MR. G. J. BURCH, who is the author, says: "Take a piece of glass tube of about ¼ inch bore, seal up the end with the blow-pipe, and continue the heat until the glass is so soft that it will fall out of shape, unless you keep turning it round; *remove it from the flame*, and blow into it with all your strength. It will be seen to swell at first slowly, and then suddenly to a large bubble of very thin glass. Supposing the tube to have been sealed up with as little glass as possible, it may be blown out to about 4 inches in diameter. When cold, break it up, and cut the pieces to shape with a 'writing diamond.' The glass in this state is of course convexo-concave; practically, this is of little consequence unless the objects are to be mounted dry, when it is liable to be broken. In order to flatten it, place a piece of thin glass on a perfectly flat piece of platinum foil, and depress it for a moment into the Bunsen flame; as soon as it is red hot, it will sink down to the flat foil. This also has the effect of annealing it. On measuring a piece of this glass with the micrometer, I found it to be=$\frac{1}{2500}$ inch=.0004 inch. In the *Monthly Microscopical Journal*, vol. viii., page 270, Dr. Royston-Pigott says: 'The thinnest glass in my possession measures 2½ thousandths.' Now 2½ thousandths = .0022, and : $\frac{0022}{0004}$ = 5.5. So that his thinnest glass is 5½ times the thickness of mine."

GOLD-COLORED GLASS.—Pagaud states that glass is often colored rose and red by means of gold. This is cast into thin plates, and these are used by the blower to give a superficial coloration to the work in hand wherever requisite. Very different tints are sometimes produced from one and the same piece of glass, varying from an almost colorless rose to an almost black red. This is chiefly due to the varying temperatures of the fluxing furnace and of the mold into which the glass is placed. The lower the temperature of both of these, the lighter is the tint. Occasionally, the plates produced in the first instance, are blue or colorless, but acquire their proper tint on reheating; hence, in all probability, this coloring matter is neither a salt nor an oxide, but is simply finely divided metallic gold. Frequently the red plates contain specks of yellow metallic gold, forming a sort of avanturine. (22)

WATER-PROOF SILK-PAPER.—R. Jacobson prepares this by floating silk-paper for a short time in an aqueous solution of shellac in borax, and then drying in the air. By the addition of aniline dye-stuffs to the borax liquor, any liquid tint can be given to the paper. (36)

USE OF SOLUBLE GLASS IN PAINTING.

FEICHTINGER states that the palace at Munich is decorated with paintings, in the preparations of which alkaline silicates have been used, and some of which have been in existence for some time. The alkaline silicate liquor used has the specific gravity of 1.12, is opalescent, and on standing forms a deposit of carbonate of lime; it leaves on evaporation 14.54 per cent of residue, composed of—

Silica	9.18
Potash	3.56
Soda	1.14
Sulphate of potash	0.66
Chloride of sodium	traces.
Carbonate of lime	traces.
	14.54

The colors used are *white* (mixtures of 27-36 parts oxide of zinc and 64-73 parts sulphate of barium), *yellow, reddish brown, and dark brown*, these last being calcareous ochres; and *black* (mixture of lampblack and maganese). They are made up into thick parts with a silicate solution containing—

Silica	51.79
Potash	39.05
Soda	9.16
	100.00

The surface on which these colors are applied is a calcareous mortar, exposed to the air for a long time.

The Société de la Vieille Montagne prepare a silicate-paint of a yellowish white, containing—

Oxide of zinc	52.70
Oxide of iron	3.25
Carbonate of lime	22.12
Sand	21.85
	99.92

This is mixed with a silicate solution, leaving behind 27.2 of residue, containing—

Silica	67.05
Potash	29.40
Soda	3.55
	100.00

Apparently the coloring matter in this case is a partially-calcined natural calamine. (36)

FUSIBLE COLORS FOR PORCELAIN, ETC.

THE following composition is recommended for the printing-oil for printing either under or on the surface of the glaze: 100 grammes of red-lead, 18 ounces of linseed oil, 12 ounces of rape oil, 80 grammes of Stockholm tar, and 150 grammes of colophony.

If it is to be used under the glaze, this mixture must be

boiled at least 3½ to 4 hours, and as slowly as possible. To ascertain if it is sufficiently boiled, a drop of the mixture is let fall on a piece of glass, when, on cooling, if touched with the finger, it will allow itself to be drawn out in a fine, thread-like filament. To be used upon the glaze, a boiling for only two hours will suffice.

Over the printed object a thin layer of copal varnish is spread, which is again removed, after the impression is sufficiently dry, by means of alcohol. (36)

CEMENT FOR PORCELAIN.

A QUANTITY of milk is coagulated by means of acetic acid, so that a thick precipitate of casein is formed. After washing this several times with water, it is dissolved in a cold saturated solution of borax. A thick but perfectly clear solution is obtained, which possesses great adhesive power, and is quite colorless. In these respects it excels gum-arabic. To this adhesive mixture finely-powdered quicklime is added. The broken ware is well rubbed over with cement, tightly bound up, and dried by a gentle heat.

PAINTING OF MACHINERY, ETC.

SOME machines—notably those connected with agriculture—are painted in execrably bad taste, with glaring, ill-contrasted colors. The following hints on this subject will be worthy of perusal: Avoid blazing contrasts of color, such as bright red, next bright green or bright blue, next bright yellow; such contrasts are not harmonious. Let one of the two colors always be subservient to the other. It is not so much what color a material is, but how that color is made to appear. It is necessary to bear in mind that all colors have their complementaries, which add to or detract from the beauty of the adjoining colors, according to what they may be. Thus, the complementaries of red are green; of blue are orange; of yellow are violet. If you cut out pieces of gray paper in an ornamental form, and stick a piece on each of the three colors I have named, you will find in a shaded light the gray will be fully tinted by the complementaries of these colors. But you can not lay down precise rules. An experienced artist can bring any two colors together by properly modulating them. I will suggest a few contrasts: 1. Black and warm brown. 2. Violet and pale green. 3. Violet and light rose color. 4. Deep blue and golden brown. 5. Chocolate and bright blue. 6. Deep red and gray. 7. Maroon and warm green. 8. Deep blue and pink. 9. Chocolate and pea-green. 10. Maroon and deep blue. 11. Claret and buff. 12. Black and warm green.

CHINESE LACQUER.—The varnish, which gives so much lustre to wood-work of all kinds, is simply a resin of rather reddish color, extracted by incision from a tree indigenous to some provinces of China and Japan.

The mode of preparing and employing the varnish obtained from this resin is as follows: The first operation consists in removing from the juice of the tree all the water, and for this purpose it is exposed to the sun for two or three hours, being stirred all the time with a wooden spatula. Without the evaporation thus caused, the varnish would not possess its beautiful transparency. Certain substances are added to produce the varieties of varnish known in Chinese industry; thus, to produce the fine ordinary varnish, pig's gall and Roman vitriol dissolved in a little water; to produce the fine black Japanese varnish, of which the Chinese remained long ignorant, powdered hartshorn, charcoal, or ivory black is mixed in certain proportions with tea oil, and added to the resinous liquid.

The design is sketched on the varnished wood with a brush and white lead; a very fine steel point is then passed over the outlines so as to trace out all the details. More often, however, the design is first sketched with pencil on paper, and finished with Indian ink. These latter designs are then carefully brushed over with orpiment dissolved in water, and are immediately applied to the varnished wood, the hand being passed over the paper, so that all the parts of the design are transferred to the wood. When the paper has been taken off, all the lines are retouched with orpiment or vermilion in gum water, which fixes the design firmly on the lacquer, and then with varnish mixed with a little camphor, which renders it more liquid; and this, when dry, is ready to receive the shell gold in powder, applied by means of a puff or dabber, over the whole of the design; the surface is then lightly wiped or rubbed, when every line of the original design becomes brilliant.

When it is desired to bring portions of the design into relief, such as the inequality of the trunks of trees, the nerves and veins of plants, etc., the camphor varnish is applied over the gold, and the gold again over that, often many times, until the desired relief is obtained. All the important lines of the design, the eyes, lips, etc., of figures, the folds of drapery, and all the ornamental portions of the work, are touched up carefully with the brush.

The lacquered work of Japan excels that of China, partly because of the superior transparency of the Japanese varnish, which is as limpid as the purest water, while that of the Chinese has always a yellow tinge; and partly be-

cause of the climate, the production of the best varnish requiring a soft, fresh, humid, and calm atmosphere; that of China is rarely temperate, almost always hot or cold, and charged with dust and salts, while Japan, being surrounded by the sea, has just the sort of air to dry varnish without causing it to become wrinkled or discolored.

White lacquer is made by mixing silver leaf, carefully divided, with the ordinary varnish; red lacquer by the mixture of mineral cinnabar or carthanum flowers; yellow lacquer with the addition of orpiment only; green is produced by a mixture of orpiment and indigo; and violet lacquer by the addition to the varnish of a certain mineral of that color, reduced to an impalpable powder. The older the articles varnished with the above, the more brilliant and beautiful are the colors.

The perfection of Chinese and Japanese lacquer-work does not depend solely on the excellence of the varnish, or the careful preparation of the various colors, for the application of the lacquer demands the most elaborate pains. In the first place, the surface of the wood to be lacquered is prepared with the greatest care; when necessary the joints are filled in with fine tow and then covered with thin strips of silk or paper. The surface is then dressed with an oil obtained from a certain tree which grows on the mountains and highlands of China; when the oil is perfectly dry, the varnish is applied. With two or three coats of varnish, its transparency is so great that all the veins and marks of the wood are perfectly distinct; to disguise the wood entirely, many more coats have to be laid on, and finally, the surface is made as smooth and brilliant as glass.

It is on such a surface that the gold and silver ornamentation is effected, and the whole, when finished, is preserved by a light coating of the varnish.

Another kind of lacquer is produced by covering the surface of the wood with a composition made of paper, tow, lime, and some other materials. This is laid on in the form of paste, and produces a solid and uniform ground, with which the lacquer amalgamates.

The lacquer and varnish are laid on with flat brushes with excessively fine hairs, at first in all directions, but equally; afterwards lightly and in one direction, each coat being allowed to dry perfectly before another is laid on. No single coat exceeds the thickness of the thinnest paper, otherwise irregularities would be produced which could not afterwards be corrected.

The workshops in which lacquered work is produced are closed in the most careful manner, in order to prevent the possibility of dust, the men even taking off all their

clothes except a pair of drawers. Contrary to all European practice, the lacquered work is dried in places which are rather damp than otherwise, and the workmen exhibit the greatest ingenuity in keeping the atmosphere therein in perfect condition. When a coat of varnish is sufficiently dry, the slightest irregularities are removed by burnishing with an instrument made of a hard composition of brick, extremely finely powdered, and mixed with a certain oil, pig's blood, lime water, and a peculiar kind of earth, common in China. The last coat of varnish is not, however, touched with the burnisher, which would dim its lustre. Upon the perfection of this last coat all the beauty of the work depends, and the greatest care is taken that no particle of dust shall reach it, and no foreign substance touch it but the hair of the finest sable. (72)

VARNISH FOR WOOD FURNITURE.—Niedlig takes :

White wax	8 pts.
Colophony	2 "
Venetian turpentine	½ pt.

heats them gently with constant stirring, pours the mixture into a glazed stone pot, and adds, while yet warm, 6 pints of rectified oil of turpentine. After standing for twenty-four hours the mass is a soft buttery substance, and is ready for use.

The articles to be varnished must be carefully cleansed with soap and water, and then dried before applying the varnish. The polish obtained is less brilliant than that obtained by shellac varnish, but it has a peculiar, chaste appearance.

COLORS FOR MECHANICAL DRAWINGS.

DRAWINGS may be, and indeed often are, merely shaded, but not colored at all, and they then occupy an intermediate position between mere skeleton line drawings and those which are both colored and shaded; when well done they are very effective, but are rather sombre and heavy looking. In colored and shaded drawings the colors may be put on first and then the shading, but the best plan is to shade first, as the subsequent tinting greatly helps to soften the shading and mellow it off. In respect of coloring, the tints for metals are, where it is possible, made to resemble those of the respective metals they are intended to illustrate, while for the three materials of cast-iron, wrought-iron, and steel, which have no greatly perceptible difference in appearance, conventional tints have to be resorted to. The annexed table shows different materials and the colors used to denote them, but at the same time the latter are not to be taken as absolute. Nearly

every colorist who practises elaboration in his work has some recipe of his own, though, of course, in the main principles all men work alike.

Cast-iron . . .	Paine's gray and a little Indian ink.
" (another tint)	Ordinary neutral tint.
" "	Prussian blue and Indian ink.
Wrought iron . .	Prussian blue (or cobalt).
Steel	A purple made by mixing crimson lake and Prussian blue.
Gun metal . . .	Gamboge or yellow cadmium.
Copper . . .	Indian red mixed with a little lake.
Wood	Burnt umber.
Brick (red). . .	Indian red.
" (yellow), . .	Indian yellow or cadmium, toned with white.
Stone color . .	Chinese white and Indian ink, toned with yellow.
Water. . . .	Broken, irregular straight lines, with liquid copperas.

WOOD PAINTING.

ONE pound of copper sulphate is dissolved in 4 litres of water, and the wood is coated with this liquid. By applying a solution of ½ lb. potassium ferrocyanide in 4 litres of water, a brown-red color (copper ferrocyanide) is produced, which is lasting, withstands the action of the weather, and is never injured by fungus growth. (36)

QUICK-DRYING OIL-PAINT COLORS AND VARNISHES.—One hundred parts of water, 12 parts of shellac, and 4 parts of borax are melted at a gentle heat in a copper vessel, with continued stirring. The vessel is then covered, and the liquid allowed to cool; after which it is kept in well-closed bottles. This furnishes an excellent varnish, giving a beautiful and durable lustre, and is perfectly secure against the action of moisture and the air. To cause oil colors to dry rapidly, equal parts of this varnish and of the color are to be rubbed up with oil, and spirits of turpentine added until the whole forms a homogeneous liquid mass. Objects coated with this mixture will dry completely in ten or fifteen minutes, according to the season or state of the atmosphere.

BARYTA-GREEN AS A PIGMENT.

THE bluish-green compounds produced by heating barium manganate and permanganate, are recommended for pigments. The shade depends on the alkalinity, to aid which 20 per cent barium hydrate should be added at the time of heating.

TESTS FOR BLUE, YELLOW, RED, GREEN, AND VIOLET DYESTUFFS.

F. VOHL gives the following tests to be successively applied:

I. *Blue.* (1.) Citric acid or diluted hydrochloric acid changes the color to red or orange. *Campeachy-wood blue.*

(2) No change with citric acid, nor with a solution of bleaching powder . . . . . *Prussian blue.*

(3.) Bleached with bleaching powder, also with caustic soda . . . . . *Aniline blue.*

(4.) No change with caustic soda . . . . *Indigo.*

Campeachy-wood blue is reddened by acids and restored by alkalies; on incineration a white or grayish ash is left, if alumina be the mordant, gray if copper. Prussian blue gives ferric oxide on incineration. No ash (save that due to the fabric) is left with aniline blue or indigo; the former can be extracted with alcohol.

II. *Yellow.* (1.) A slightly acid solution of ferrocyanide of potassium gives a blue tint . . *Rust* or *oxide of iron.*

(2.) Solution of potassium cyanide gives a blood red. *Picric acid.*

(3.) Boiling solution of soap (0.5 per cent of soap) gives a reddish brown coloration, restored by acids . *Turmeric.*

(4.) Do., gives a very dark coloration . *Yellow wood.*

(5.) Decolorized by boiling sulphuric acid , *Gaude.*

(6.) Not decolorized by sulphuric acid; changed to orange with boiling tin salts . . *Grains of Persia.*

(7.) Do., no change with do. . . . *Quercitron.*

(8.) Changed to bluish green by sulphuric acid. *Annatto.*

Annatto is not decolorized by chlorine.

III. *Red.* (1.) Boiling soap decolorizes, color not restored by lemon juice . . . . . *Carthamus.*

(2.) Do., color restored by lemon jnice, but not so deep . . . . . *Aniline red.*

(3.) Do., color becomes reddish yellow or pure yellow with lemon juice . . . . *Cochineal* or *Brazil-wood.*

(4.) No change with boiling soap, ammonia, lemon juice, and tin salts with diluted hydrochloric acid . *Madder.*

Strong sulphuric acid changes the color of goods dyed with Brazil-wood, to a cherry red; with cochineal, to a yellow orange.

IV. *Green.* Three sorts of color are in use, viz., those due to a mixture of a blue and a yellow, aldehyde green, and iodine green: of the first class, indigo and picric acid, or other yellow dyes; Prussian blue and picric acid, or other yellow dyestuffs; and aniline blue and picric acid, or other yellow dyestuffs, form the cheap varieties.

If alcohol dissolve out a green color, aniline blue and a yellow soluble in alcohol are present (aniline greens being absent); heat on the water bath for some minutes with 95 per cent alcohol.

(A.) The alcohol becomes yellow, the fabric remaining blue; the blue color is indigo or Prussian blue: extract all the color that alcohol will take out, and test the fabric with bleaching powder.

Indigo is bleached, Prussian blue unchanged; the yellow dyestuff extracted by the alcohol is tested as above.

(B.) The alcohol becomes green, the fabric remaining green, but paler.

(1.) Boil with dilute hydrochloric acid; the tint becomes rose or lilac . . . . . *Iodine green.*

(2.) Do., fabric decolorized or changed to yellow *Aldehyde green.*

(3,) Do., the liquid becomes yellow, while the fabric becomes blue . . *Aniline blue and a yellow dye.*

The yellow dyestuff in this case is characterized as above.

V. *Violet.* (1.) Bleaching powder no result . *Alkanet.*

(2.) Bleaching powder bleaches the tint; lemon juice brightens the tint . . *Iodine violet* or *Aniline violet.*

(3.) Bleaching powder bleaches the tint; lemon juice changes to red or yellow.

Madder violet, Archil, cochineal, Campeachy violet.

With madder, bleaching powder yields a yellow tint, with cochineal the color is quite destroyed; the bleached fabric becomes blue, after washing with ferrocyanide of potassium, from the iron mordant in these two cases. With campeachy violet, milk of lime first changes to gray and finally renders nearly colorless, whilst with archil it produces a blue violet.

Hydrochloric acid diluted with three volumes of water changes ordinary aniline violet to a blue violet, becoming reddish after washing, and converts iodine violet into a greenish shade, becoming pale lilac or gray after washing.

On incineration, ashes containing iron indicate madder or cochineal (iron mordant); white ashes archil or campeachy-wood; no ashes save those due to the fabric, aniline violets. (22)

COTTON BLUE WITHOUT MORDANT.—Bleached cotton blue should be used, being passed through a dilute alkaline solution before use. The dyeing should be begun cold, the temperature being slowly increased to 40° R.; 15 to 20 grammes will dye a kilog. of goods. Silk may be dyed in the same way.

BRONZING ON COPPER.

TEA-URNS and similar articles are often desired of a brownish bronze color. To effect this, the article must be taken to pieces, and all solder, etc., removed by firing and rubbing with tow. The article must then be "pickled," by being painted over with spirits of salt applied with a tow-brush, and then scoured with a fine coke-dust until quite clean. It is then to be well rinsed in clean water, the outside being immediately afterward smeared over with thick paste of whiting. The outside must now be tinned with bar-tin and sal-ammoniac. The outside only must now be pickled in spirits of salt, mixed with its own weight of water, again well rinsed, and scoured with very fine sand and water, until the surface is perfectly clean and bright, taking care, as far as possible, to rub only in one direction. The article being again rinsed, is beaten with a wire brush, and dried in hot sawdust.

Having chosen some moderately fine crocus powder, of a full, but not too dark tint, the operator proceeds to make it up into a cream with water. This is to be brushed over the article with a stiff brush, the article being held by a cloth to prevent the perspiration staining it. A good, clear coke fire must now be at hand, through which a blast can be blown at will. All the sulphur having burned off the coke, the article is held over the fire, having previously brushed off all the crocus. Again the crocus cream is to be applied with a good wide brush, so as not to run, and, holding the article by the tongs, it must be held over the clear blast until quite dry. A piece of glassy coal, about as big as a filbert, is now to be thrown on the fire, and the article turned continuously in the rising smoke, until it is quite black. It is now removed from over the fire, until this latter burns again perfectly clear and smokeless, when the article is once more to be held over the blast until all the smoke is burnt off. When cold, the crocus is brushed off, and the crocusing, smoking, and burning operations, repeated until the desired tone is obtained. The usual way of finishing off, is to hammer up with bright hammers shaped to parts, the back being sustained by leather or lasting-covered tools.

DRYER FOR OIL-COLORS AND VARNISH.

TWELVE parts of shellac and four parts of borax are heated in a copper vessel, with 80 to 100 parts water, when after the excess has become homogeneous, the vessel is closed, and its contents, when cold, are poured into flasks, which are kept closely corked.

This solution may be used as a quick-drying varnish, when mixed in equal weights with oil colors, it causes them to dry quickly.

TREATMENT AND PRESERVATION OF LITMUS.

THE violet assumed by litmus in the titration of solutions which do not contain carbonates, says F. Mohr, is due to the carbonic acid contained in the litmus itself. If this be expelled by acidifying with dilute sulphuric acid and then boiling for some time, the litmus, after treatment with baryta water, changes from blue to red without any intermediate violet. In titrations with litmus, if the final color is to be blue, blue litmus should be added first; if red, the red solution must be used. In this way all errors arising from the litmus itself may be avoided.

The coloring matter of litmus, when purified as much as possible, may, says J. Martenson, be kept for an indefinite period in glycerin. Litmus is treated with hot water, and the solution, after concentration, is mixed with a sufficient quantity of alcohol (of 80 per cent) to precipitate the coloring matter. After standing for 20 hours the alcohol is poured off, and carries with it a dirty blue foreign substance which frequently occurs in litmus, and is not altered by acids. The sediment is treated with hot water, which dissolves it on account of the potassium carbonate which is present. To remove this carbonate, sulphuric acid is added till the liquid assumes a faint wine-red tint; it is then heated to boiling for a few minutes, and again rendered blue by the addition of a few drops of lime-water. After the lapse of 24 hours the liquid is filtered and evaporated to a syrup, and left all night in a cool place, when the potassium sulphate crystallizes out in the form of a crust. It is then filtered through moist loose cotton, mixed with glycerin, and carefully preserved from damp.

(32)

CHROMIC ACID AS A DYE.—E. Jacquemin finds that chromic acid can combine with silk and wool, giving a yellow compound that resists washing and soaping. The wool is first passed through a bath of carbonate of soda at 60° C., containing about one-fifth as much carbonate as there is used of wool; it is then washed and introduced into the following bath (per kilog. of wool):

Bichromate	60 grammes.
Sulphuric acid at 66° B	60 "
Water	40–50 litres.

For light straw yellow, the wool is kept in for a few minutes at 30° C.; for darker shades, twenty minutes at a temperature not above 60° is required. Wool thus prepared takes up aniline and other colors, with more or less modification of the shades, according to circumstances.

(4)

SUMACH EXTRACT.

INSTEAD of sumach, the extract of this coloring matter has of late been used, and has rapidly gained ground in importance. It is prepared by boiling the sumach with water, and careful evaporation on the water-bath, usually with the aid of the vacuum apparatus. It comes into the trade as a thick syrup, having a pure astringent taste, and without the slightest admixture of acid. As is known, the tannic acid in the ordinary sumach extracts quickly oxidizes to gallic acid, and thus sumach decoctions very soon become acid and unusable. The sumach extract, however, will keep for a long time free from acidity. This remarkable circumstance is attributed to the high state of concentration of the extract. To be ready for use, it merely requires to be diluted with hot water.

For the treatment of ordinary cotton-yarn, leaf-sumach will probably still hold its ground, the extract being too dear for the purpose ; but in the dyeing of calico and wool, the higher price of the extract will not be considered an objection, when weighed against the many inconveniences attending the use of ordinary sumach. (36)

NEW COLORING MATTERS.

IF wood, horn, bran, starch, moss, shreds of wool or paper, bark, aloes, etc., be heated with caustic soda-water and sulphur under pressure, at 250° to 300°, sodium sulphide is produced, which acts on the organic matter, liberating hydrogen sulphide. A black hygroscopic mass is obtained, soluble in water, with a green color. Cloth can be dyed with it, without the use of a mordant. All shades, from a greyish lilac to deep brown, can be produced. (36)

LILAC FOR COTTONS.—Sauvage gives the following recipe : Fifty kilogs. of goods are passed through an indigo bath, washed, treated with a weak tannin bath, and finally passed through a bath containing 1.5 kilogs. of bichromate. After washing, the goods are allowed to remain in a bath made from 7.5 kilogs. of sandalwood and 3.5 kilogs. of logwood for an hour in the cold, after which the bath is heated to boiling for an hour. They are then taken out, whilst 4 kilogs. of alum and 4 litres of hydrochloric acid are added to the liquor, after which they are again immersed. Finally, they are washed and wrung, and passed through a bath of logwood and alum ; after twelve hours they are washed and treated with oil. In one week the operation is completed, instead of requiring six weeks; a less expensive fabric can also be used.

SIZE FOR COTTON YARNS.—H. Wegmann patents an improved compound for sizing cotton-yarn, consisting of tallow, soft-soap, resin, vitriol of iron, and onions. This compound is designed to be added to 25 lbs. or 75 lbs. of starch, or 50 lbs. to 100 lbs. of flour, the resin, vitriol, onions, and tallow being boiled till rendered sufficiently liquid to mix freely with the other matters; then the soap is melted in a tank separately, by hot water and steam, and the above mixture added. The ingredients are thoroughly mixed with steam, and then added to the starch or flour in another tank, together with the proportion of water requisite for making the sizing more or less stiff, according to the size of the yarn for which it was intended, the starch or flour being also varied to suit the case.

COMPOSITION FOR CLEANSING AND BLEACHING TEXTILE FABRICS, PAINT, FLOORS, CASKS, ETC.—W. A. White patents the use of the following compositions:

No. 1.

Carbonate of potash	22 parts.
Sand free from alumina and iron	50 "
Charcoal	2 "

No. 2.

Carbonate of soda	22 parts.
Carbonate of potash	70 "
Silicate of potash	20 "
Charcoal	1 part.

No. 3.

Silica	1 part.
Common salt	2 parts.

ANILINE COLORS ON LINEN.—Haissch employs the following process for communicating to linen the aspect of silk. The goods are successively introduced into the following baths for ten minutes in each instance:

No. 1.

Tannin	1 kil.
Water	500 litres.

No. 2.

Glycerine	1 kilog.
Water	32 litres.

A little white of egg may be advantageously added to No. 2; for very delicate shades No. 2 only is used.

SOAP FOR CLEANSING TEXTILE FABRICS.—Decurty suggests the following composition:

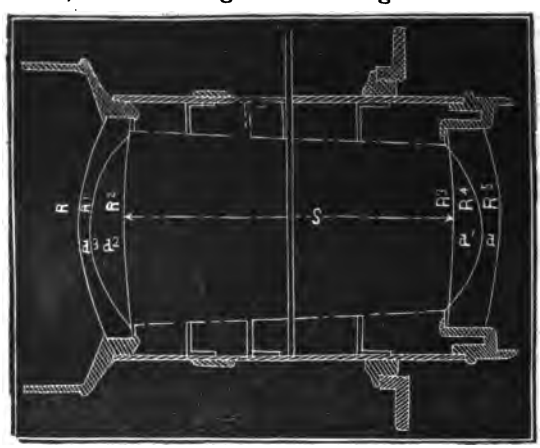
Water	1,000 litres.
Olive oil or oleine soap	0.52 kilogs.
Soda	2.11 "
Lime water	0.71 litres.
Cheese flour	0.05 kilogs.

ANTI-MILDEW SIZE.—R. K. Whitehead renders the materials employed for sizing yarn, woven fabrics, etc., proof against mildew by the addition of a little mustard-oil, or other vegetable oil possessing antiseptic properties. About four ounces of oil to one gallon of size is usually sufficient.

A NEW PORTRAIT LENS.

THE authors of this new lens—Dr. Adolph Steinheil and Edward Steinheil, of Munich—seem to attach much importance to the fact of its great rapidity of action, as compared with those of the usual construction; but this is, to a large extent, a question of angular aperture.

The method of forming the new lens will be seen from the accompanying diagram, which is a longitudinal section of the apparatus, d, d^1, d^2, and d^3 being the several parts of the lenses, d and d^1 being cemented together to form one



lens, and d^2 and d^3 being cemented together to form the other lens.

The patentees say that the curves of the several glasses which compose the lenses differ from the aplanatic lenses for landscapes and groups as made by them, and in well-known and common use, and also from those well known as Dallmeyer's rectilinear lenses (which also consist of two pairs of cemented lenses), in not being formed or ground symmetrically and alike, but dissimilar, and in such manner that while the surfaces R^2 and R^3 have curves of equal or nearly equal radius, the radius of the surface R^4 is shorter than that of R^1, and the radius of R^5 longer than that of R. Tne first and fourth lenses are made of flint glass, and the second and third of crown glass.

The particular size and dimensions shown in the diagram are only in illustration of the invention, which may be put in practice on a larger or smaller scale.

"By our novel method," say the patentees, "of forming and arranging the lenses, more pure and undistorted images are formed than by any other method, and it is applicable not only to lenses for obtaining photographic portraits, but to lenses used for other optical purposes where bright and undistorted images are required to be produced. We claim the arrangement of two lenses, each of which consists of two parts cemented together, but which are not formed or ground symmetrically, substantially as and for the purposes described; also the construction of these lenses in such a manner that the surfaces R^2 and R^3 (as shown in the drawing) have curves of equal, or nearly equal, radius, while the curve R^4 is of shorter radius than that of R^1, and that of R^5 of longer radius than that of R, substantially as described and shown in the drawing."

THE GLACE OR ENAMELED PHOTOGRAPH.

THE glass upon which the enameling is to be done must be scrupulously clean. Plate glass, free from scratches, is the best, although good photograph glass will do if not scratched. Blisters in the glass hurt nothing. After it is thoroughly clean, sprinkle over it, by means of a five cent pepper-box, powdered talc (or French chalk), and with a tuft of cotton rub in a circular motion (carefully going over the whole surface) until no trace of the chalk is perceptible. Do not rub heavily. The chalk gives a surface to the glass that assists in the lifting the enameled print from it. Now flow the plate with collodion made as follows: Ether 4½ ounces, alcohol 3½ ounces, cotton to thicken (say from 5 to 7 grains to the ounce of solution), and 24 drops (or minims) of castor-oil. When this flow is dry, apply the prints face down, after immersing them in a gelatin solution made as follows: Coxe's gelatin 1 ounce, water 8 ounces, glycerin 50 drops. Add the gelatin and glycerin to the water, and let it stand over night, when it will be ready for use after filtering, which can be done by warming sufficiently to make the solution limpid. Allow the prints to remain in this solution about five minutes before laying them on the collodionized glass, and then pass a gum roller lightly over them to press them tightly to the glass, and also to remove the surplus gelatin. After the prints are nearly dry, they are ready for the mounts. For this purpose, light Bristol board is best. Use the gelatin solution for mounting, and mount on the glass as the prints lay. The whole thing must be perfectly dry before an attempt is made to remove them from the glass. When they are dry, run a knife blade around the edge to start them up; and if thor-

oughly dry and the work properly done, they will come off all right. "I forgot to say, in the proper place, that it is a good idea to lay upon the back, after the mounts have been applied, a weight of some kind, say a heavy piece of glass, which should remain there for an hour at least. This assists in securing a complete contact to the print. At the end of an hour remove the weight and leave the print, back up, until perfectly dry all through. Sometimes they start off without help, which shows perfect success. Remember that careful manipulation is the only surety for success. A little experience will enable any one to perform this operation well." (138)

THE IMITATION OF LACE ON SILK BY PHOTOGRAPHY.

A NEW and beautiful application of photography has lately appeared in England, by the aid of which any lace design can be transferred to silk, so that the latter material appears to be covered with the delicate and costly fabric. The lace to be copied is secured in a frame in contact with sensitive albumenized paper, and exposed to the light until a very deep impression is obtained. This is then fixed, and the paper, washed and dried, forms a perfect negative. Another piece of paper is then sensitized with bichromate of potash and gelatin, and exposed under the negative. Inking with lithographic transfer ink follows, and the paper is placed in water and lightly rubbed with a sponge. This throws out every detail of the inked spaces, the rest remaining white or free from ink. The impression is lastly transferred to a lithographic stone, and thence printed upon the silk by the usual process.

PHOTO-STEREOTYPES.

BY F. FINK.—A sheet of ordinary plate-glass, larger than the picture to be reproduced, is coated in the dark-room with a solution made by dissolving 1 ounce of potassium bichromate in 15 ounces of water, warming gradually, then adding 2 ounces of fine gelatin, and filtering through linen at the boiling heat. A diapositive is taken from an ordinary negative, and laid with the collodion side to the gelatin face of the prepared plate in diffused light for 10 to 30 minutes. The plate is then taken from the frame in the dark-room, and washed with water for five to ten minutes, till the relief is fully developed. The plate is then dried with filtered paper, and coated with glycerin by means of a camel-hair pencil, and the excess of liquid is removed with filter-paper. From this plate a cast is made in plaster-of-Paris of the consistency of oil, and from the plaster cast a metal one may be taken. (36)

PHOTO-PRINTING WITHOUT A PRESS.

By R. Jacobsen.—A carbon picture is prepared on a glass plate in the usual way, and the picture is surrounded by a wooden frame which exactly incloses the glass plate. Afterward there is poured on a moderately warm mixture, consisting of 1 part gelatin, 1 part gum-arabic, and 2 parts gylcerin. This must possess the properties of the mixture used by the ordinary printer. When solidification has taken place, the frame or rim is carefully removed with a hammer, and the gelatin plate, which has united itself with the carbon picture, is carefully turned over. With respect to the printing, the blackening of the picture is performed with a glass roller, and is best managed with an elastic runner, as practised by the ordinary printer. The printing ink, which must be of good consistency, is dissolved in oil of turpentine or benzol. This solution, without addition of varnish, is poured on the plate and distributed and spread therein by the glass roller. A non-coagulated albuminized paper is now spread over the blackened carbon picture, with due precautions. The paper should not lie too long on the plate, otherwise the albumin layer is apt to dissolve, and soil the plate. Moistening the plate with water is not necessary, as the plate is moist enough for the printing of a dozen pictures. Of course, after continuous use, it exhausts itself at last, but still it is hydroscopic enough to absorb moisture in a few hours, to be ready again for printing. This method has the advantage that the print is obtained in relief; also that round or cylindrical objects, as flasks, vases, etc., can be printed. (90)

New Perspectograph.—A. R. East patents an improved perspectograph, the object of which is to provide a simple and efficient mechanical apparatus by which to take the points or boundary lines of all visible stationary objects accurately, and transfer them to paper on a sketch board. This is done by two perpendicular bars, which extend from a bed-piece. On one bar are two sleeves, the lower of which carries a horizontal arm, the further extremity of which is slotted to receive the second perpendicular bar. On the horizontal arm slides a vertical rod, through which, at its upper end, passes another horizontal arm, which is attached to the upper sliding piece on the bar first mentioned. Pivoted to either sliding piece at will is a converging arm, which carries one eye-plate on a vertical staff. On all these portions, except the swinging arm, are marked scales. A single example of the mode of using the instrument will suffice to show its application. To operate by the use of the perpendicular

scale and the horizontal scale on the upper sliding piece, or, in other words, to take field notes by latitude and departure, using the sliding scales, slide the horizontal scale to the top of the meridian, and move the scale of latitude (the vertical rod on the lower horizontal arm) to the extreme right. An object in the foreground in the extreme left, and nearest to the observer, is selected and regarded through the eye-plate. The scale of latitude on the base is next moved till it comes in direct line with the eye and the said point. Then the horizontal scale at the top of the meridian is loosened and moved down till it also comes in direct line from the eye to the object, and the angle of incidence, or the latitude and departure of the point of the object, is found at the intersection of the two scales. A horizontal scale on the plat-board is moved until it cuts the degree of latitude of the point in the object, and the dotter is fixed to the angle of longitude or departure. By a gentle pressure on the dotter, the point is carried on the paper. In this way the operation is carried on from object to object, and from point to point, until the entire field is gone over.

PHOTOSTEREOTYPY.—F. Fink proceeds in the following manner: A glass plate, larger than the desired picture, is coated in the dark room with a solution of 1 oz. of potassium bichromate and 2 ozs. of gelatine in 15 ozs. of water, the solution having previously been filtered hot through linen. A diapositive is taken from a negative, and put with the collodion side to the gelatine face of the prepared plate in diffused light for 10 to 30 minutes. The plate is then taken from the frame in the dark room, and washed with water till the relief is well developed. The plate is then dried with blotting-paper, and coated with glycerine by means of a camel-hair pencil. A cast is made from this plate in plaster-of-Paris, and from this cast a metal one may be taken.

ARTIFICIAL STONE.—J. Noyes is the author of the following improvements in the manufacture of artificial cements and stones: 1. The combination of cement sand, or other suitable mineral substances or material, and an aqueous solution of gum copal to form a compound for making artificial stone and concrete, or for other purposes. 2. In the manufacture of the artificial stone concrete, or similar material, the use of an aquous solution of gum copal. 3. A process for manufacturing or producing an aqueous solution of gum copal by boiling gum copal in soft water, and adding thereto subcarbonate of soda or caustic acid, or other alkaline substance.

MOSAIC PLATES OR TILES.

H. SEGER has experimented on mosaic stones of great beauty and purity of tint, one sky-blue, the other chocolate-brown. They were of Spanish manufacture. These mosaics are esteemed for building purposes; they are triangular plates one-third of an inch thick, and have apparently been cast in metal molds, judging from their sharp edges. They are unglazed, and have a fracture resembling that of a piece of broken porcelain.

It is considered probable that the materials used for the manufacture of these mosaic tiles consist of kaolin, felspar, and quartz. To the mixture of these are probably added the following coloring materials: Smalt for the blue tiles; for the brown a mixture of ferric and manganic oxides, or a very ferruginous native manganic oxide. In the blue tiles, the presence of zinc is considered to have, in all probability, some modifying effect on the development of the tint.

HOLLOW IRON FURNITURE.

AMONG recent industrial developments in Germany, we have to notice that of hollow iron furniture, the use of which in Austria has been popular for years. In Germany, however, it is only quite lately that the first large factory for making this class of goods has been opened. Ribbon-iron, of the best quality, is taken and converted into tubing in pieces of about five metres long, which can be bent cold into any form suitable for the making of bedsteads, chairs, tables, etc. Hollow iron is stronger than solid iron, such as that usually employed heretofore, and possesses the special advantage, that the rivets hold better, and that it does not itself break so easily, as is frequently the case in solid iron, which gives way where there is a flaw.

IMPROVED STUCCO.—M. Landrin recommends the mixing of the crude plaster in water containing 8 to 10 per cent of sulphuric acid. After allowing the compound to rest for fifteen minutes, he calcines the plaster. This gives a stucco of excellent quality, in which all organic matters are burnt out, leaving the material of exceptional whiteness.

BEER FROM BEET-ROOT.

FR. COALES has recently patented a process for the manufacture of beer from beets free from any disagreeable taste. The beet-roots are mashed, crushed, and extracted with *boiling* water, and an equal weight of roasted malt is added; the ordinary process is then pursued. The crushed beet is used as food for cattle.

PRESERVATION OF FOOD.—E. D. Nicolli and S. T. Mort propose the following method: The substances to be preserved are first subjected to a temperature of about 60° below zero, and in hermetically-closed vessels, by which means the germ or ferment is destroyed, and the substance, if kept from atmospheric air, will not ferment or putrefy, although the temperature may be raised. If desirable, the interstices in the tins may be filled up with concentrated meat-juice, gelatine, etc. The air may be removed by antiseptic gases, also cooled to the temperature necessary for destroying the germ for ferment in the meat. The agents preferred for producing the requisite cold are highly compressed air or gases, which are subsequently allowed to expand in pipes or around the meat-containing vessels; or the same result may be arrived at by the liquefaction and subsequent gasification of ammonia, as in the Carré ammonia machine and other analogous arrangements. (114)

NEW PROCESS FOR SUGAR MANUFACTURE.—Auteuil de Savignon proposes to break the cortical membrane of the sugar-cane by mechanical means, and then to dry the canes cut into suitably-sized portions or discs. When required to extract the sugar, these discs are treated with cold water, whereby a pure solution of sugar is immediately obtained of sp. gr. 15° B., and containing very little glucose. The operations of refining are thus much shortened, while the fermentation taking place in the cut canes is obviated.

ARTIFICIAL FUEL.—D. Barker suggests the following improvements in the manufacture of artificial fuel, for the purpose of utilizing coal, anthracite, lignite, etc., when in a state of powder, and rendering them suitable for smelting iron, or other purposes requiring a very high temperature. If coke is the article of manufacture, it is first powdered, mixed with mucilage, and pressed into blocks. If anthracite is employed, it is first coked, and then treated as the foregoing. The mucilage is made by mixing one part of the farina, from which the gluten has been removed, with twenty parts of water, and adding thereto a solution of sulphate of alumina in water.

ALFRED ARNOLD, of Tenafly, N. J., has invented an egg-cooker, which consists in attaching a spring and clock-work to an egg-cooking vessel, in such a manner that on setting the clock-work to run for a certain number of minutes, the cover will fly up at the designated moment, and thus stop the cooking. Eggs can thus be boiled to a dot, in exactness. A bell to give an alarm when the time is up may be struck, if desired, by the clock-work.

THE FRENCH AND THE ENGLISH MEASURES.

So far as my own experience goes, having had the opportunity to use the inch and millimetre in one and the same establishment for many years, using one with as much familiarity as the other, my choice is most decidedly in favor of the inch as the unit of measurement in the machine shops, and on the railroads of the country. That others think so too, in regard to one question in mechanics, let me prove by an example. Many years ago, Mr. Whitworth attempted to establish a uniform system of screw threads based on the inch as its unit. His scheme met with such success that now, with the exception of France only, all the metre-using peoples of the world have adopted the Whitworth system, and it has even been largely adopted in this country. It is considered better and more convenient than the French system. According to Mr. Whitworth's system, a half inch screw should have twelve threads to the inch, To express this in the metric language, a bolt 12.7 millimetres should be 2.12 millimetres pitch. I have said business men count the cost before making changes in matters of habit or use, but when they can be shown that they will be gainers by the change, they give into it heartily. The same example of screw threads will serve as an illustration. Mr. Whitworth's system of screw threads was already introduced in all the principal workshops of Europe, and in many in this country. But a better system was presented to the Franklin Institute—a system based on such simple laws that, given the formula, with no existing original to copy, any careful workman can originate a given thread that will match those in use. After an exhaustive debate on the subject of its introduction by the various departments of our Government, and a careful consideration on the part of our mechanical associations, it came to be adopted as the United States standard. It was adopted at considerable expense, because it was believed to be an improvement on existing practice. We have still to keep up our old taps and dies for repair work, but no mechanic has deemed the expenditure involved in the change other than judicious.

Recognizing the advantages offered by the decimal system in money, we accept the dollar and cents in preference to the pound sterling of England. We now have in use, in land-surveying in the country, the chain and its decimal division. In city measurements, the foot and its decimal division is also used; and in mechanics we have the inch as our unit, with its division into one-hundredths for calcu-

lation, and into vulgar fractions, where its written expression is rendered plainer thereby. I have in this paper made no attempt to discuss the merits of the metric system as carried out in all its perfection, through measures of distance, surface, solidity and weight. This has been considered by abler men thau I am. My object has been to present to you the cost involved in the change, and to show that something more than want of education strengthens the hands of Englishmen and Americans in resisting any change in their methods of measurement. By the law of our land, those of our citizens who choose to use the metric system can do so, and their so doing will meet all requirements of the law; but the standard of the land is, for our purposes, the inch, and I for one should be sorry to see it abolished.

If, as I am imformed, some of our schools of science see fit to make their method of teaching dependent on the metre and its divisions, to the exclusion of the ordinary nomenclature of the land, their wisdom may well be questioned. We need educated engineers, but we need them educated in our mode of thought. The universities of the land are awake to the need of scientific education, and our sons are sent to them that they may learn what will be of the most use to them in active life. We wish them to learn the languages of other leading lands, but we insist that they shall know their own language. We would have them read the scientific languages also, but if, for good reasons, we choose to retain our technicalities, deeming them more convenient for our use, we also insist that they shall know how to use them in our business relations.

Impressed as I am with the insurmountable difficulties in the way of a change in our unit of measurement, even if that change was desirable, I can not help thinking that, if the hypothetical New-Zealander, when he has done contemplating the ruins of St. Paul's, from the sole remaining vestige of London Bridge, in the far-off distance of the future, shall seek from the ruins of a mighty city to learn the nature of a nation's greatness, and shall measure its length and breadth, as did Prof. Piazzi-Smyth the Pyramids, he will find its unit of measurement to have been the inch.—*Coleman Sellers.*

WHITE COAL.—A new kind of fuel has recently been discovered on the Australian continent, which has received the name of white coal. It consists of felted vegetable fibres, like peat, which contain interspersed between them fine grains of sand. It is easily combustible, and burns with a light flame. The white coal covers large tracks, requiring no mining, and is already used in large quantities as fuel.

MANUFACTURE OF PRECIOUS STONES.

AN address on clay and its economic application was recently delivered by Professor T. C. Archer, on the occasion of the inaugural meeting of the fifty-fourth session of the Royal Scottish Society of Arts at Edinburgh.

One of the greatest discoveries of the present age, he said, was the obtaining of the oxide of alumina in a pure crystalline state. It had long been known that the precious stones were composed of oxide of alumina covered by other metallic oxides; and it was a very fair inference that if they could succeed in melting the oxide of alumina, there was nothing in the world to prevent the manufacture of emeralds, sapphires, rubies, etc., This had actually been accomplished by a Parisian chemist, and the artificial gems were of the same hardness and density as, and chemically identical with, the real stones. Beautiful stones were exhibited, after which the Professor proceeded to explain the composition of the various kinds of clay, and to detail the uses to which they had been put from the earliest periods of history. He spoke also of the restoration of the lost art of encaustic and mural tile-making, and described how those beautiful ceramic articles were manufactured, and the manner in which they were salt-glazed. The introduction of this kind of ware into the building of houses would, he said, add much to the beauty of our architecture—the more especially as the atmosphere had no effect upon their coloring, as in the case of serpentine and even granite. He next touched on the application of salt-glazing clay to sanitary appliances and gas retorts, and concluded by a reference to the improvements made of late years in the construction of pottery-kilns, which had the effect of saving fuel to the extent of one-third.

IMPROVED FILTER.

RICHARD L. GENTRY, Richmond, Ky.—This is a filtering apparatus, through which rain or other water is passed before being collected in the cistern, or otherwise applied for use. It consists of an outer and inner chamber filled with filtering material, to which the water is admitted by a supply pipe passing through a perforated bottom of the outer chamber and side apertures of the inner chamber into the latter, rising therein until reaching the height of the central discharge pipe, from which it is carried to the cistern or other place. A perforated outlet hole of the discharge pipe, near the bottom of the inner chamber, drains the filtering material from the remaining water, while a screw spout of the outer chamber allows the cleansing of the filter from impurities.

HARDENING SAWS AND SPRINGS.

SAWS and springs are generally hardened by being immersed in various compositions of oil, suet, wax, and the like materials. The usual way of proceeding is to heat the saws in long furnaces and then to immerse them horizontally and edgewise in a long trough containing the composition; two troughs are commonly used alternately. Part of the composition is wiped off with a piece of leather, when the articles are removed from the trough; they are then heated one by one over a clear coke fire until the grease inflames; this is called "blazing off."

A greatly recommended composition consists of two pounds of suet and a quarter of a pound of bees wax to every gallon of whale oil; these are boiled together, and will serve for thin articles and most kinds of steel. The addition of black resin, to the extent of about one pound to the gallon, makes it serve for thicker pieces, and for those it refused to harden before; but the resin should be added with judgment, or the articles will become too hard and brittle. The composition is useless when it has been constantly employed for about a month; the period depends, however, on the extent to which it is used, and the trough should be thoroughly cleaned out before the new mixture is placed in it. The following recipe is recommended:

Twenty gallons of spermacetic oil; twenty pounds of melted and strained beef suet, one gallon of neatsfoot oil; one pound of pitch; three pounds of black resin.

These last two articles must be previously melted together, and then added to the other ingredients; the whole must then be heated in a proper iron vessel, with a close cover fitted to it, until the moisture is entirely evaporated, and the composition will take fire on a flaming body being presented to its surface; the flame must be instantly extinguished again by putting on the cover of the vessel.

When the saws are wanted to be rather hard, but little of the grease is burned off; when milder a large portion; and for a spring temper, the whole is allowed to burn away.

When the work is thick, or irregularly thick and thin, as in some springs, a second and third dose is burned off, to insure equality of temper at all points alike.

Gun-lock springs are sometimes literally fried in oil for a considerable time over a fire in an iron tray. The thick parts are then sure to be sufficiently reduced, and the thin parts do not become the more softened from the continuance of the blazing heat.

Springs and saws appear to lose their elasticity after hardening and tempering, from the reduction and friction

they undergo in grinding and polishing. Toward the conclusion of the manufacture, the elasticity of the saw is restored principally by hammering, and partly by heating over a clear coke fire, to a straw color; the tint is removed by very diluted muriatic acid; after which the saws are well washed in plain water and dried. (114)

SUBSTITUTE FOR BELLS.—Mr. J. A. Judson, C.E., writes from Dutch Island, near Newport, R. I., that for several years past he has used a steel bar in place of a bell, with very satisfactory results. He caused a bar of steel about one inch and a half in diameter to be forged into an equilateral triangle of about three feet on a side, without uniting the two ends, thus forming an instrument similar in all respects except size to the rude musical appliance called the "triangle," used by negro minstrels, and sometimes in brass bands. This is suspended from one of its angles by a rope attached to a simple wooden frame, and is struck by hand with an ordinary steel-faced blacksmith's hammer. A cord attached to the triangle and held in the left hand of the ringer prevents its whirling about when struck. If necessary, it may be permanently lashed, without materially interfering with the vibrations, and could then be rung by some stationary mechanical device. "I may have been fortunate," says Mr. Judson, "in finding an especially suitable bar of steel for the purpose, for it is certainly sonorous and powerful, answering all the purposes of an ordinary factory-bell, at merely the cost of so many pounds of steel, and a few hours of skilled labor." (77)

CONCENTRATED MINERAL MANURE.—E. Packard prepares manure, consisting of lime, superphosphate, and ammonia sulphate, which is especially adapted for transport to distant places. Any phosphate of commerce is treated with a quantity of sulphuric acid slightly in excess of the amount necessary to render the phosphate soluble. The thick pasty mass is allowed to rest twenty-four hours, and is then diluted to the consistence of a thick cream. Ammoniacal liquor from the gas works or other suitable source is then added until the solution gives but a faint acid reaction.

The solution thus prepared is allowed to subside, and the clear liquor removed and evaporated to dryness, when it is ready for the market. Or the solution is concentrated, and suitable drying materials added, so as to produce a manure of any desired strength. The residue is washed with water, the dilute liquor obtained being employed in the next operation for reducing the pasty mass to a creamy consistence.

NEW COMPOUND OF RESIN AND LARD.

PROFESSOR OLMSTED read a paper before the American Association for the Advancement of Science, on a new and important compound of resin and lard. It is best made by adding one part of resin, in fine powder, to three parts of lard, and stirring the mass well, without the application of heat. The compound is more easily fusible than lard, running freely at 72°. The addition of resin prevents in the lard, its tendency to spontaneous decomposition or rancidity. Hence it is valuable for lubricating articles of brass and copper, such as the barrels of air-pumps, stop-cocks, etc. It may be used either with or without black-lead, to protect stoves, grates, and iron piping from rust. The new compound forms also an excellent water-proof paste for leather which does not rub off, and admits of the subsequent application of blacking. The addition of a small quantity of resin to lamp oils greatly increases their illuminating power, and renders them less liable to coagulate.

SECTIONS OF INSECTS' EYES.

MR. R. PACKENHAM WILLIAMS, in a recent paper "On Cutting Sections of the Eyes of Insects for the Microscope," first described the method of preparing the head for cutting, the most successful plan being first to shake the insect gently in a phial of benzine—then to soak it in alcohol 60° over proof for a time varying from four to forty eight hours—this was considered to be the most difficult part of the operation, some specimens becoming hard sooner than others; and it was suggested that the best preparations might possibly be made from insects just on the point of emergence from the chrysalis. The head, after being hardened, was to be imbedded in a mixture of butter of cocoa and bleached beeswax, with the addition of a little uew Canada balsam. This compound melted at about 120°. The head was to be placed in the wax so that the cut should be at right angles to the chord of the segment forming the outline of the eye, the most satisfactory section being that in such a direction as to show the structure of both eyes. The cutter was to be wetted with spirits of turpentine, and one cut having been made, a little wax of a lower melting point was applied to the cut surface, so that the next section might be supported by a thin film of wax, and the cavities of the head were also to be filled with wax so as to give more effectual support. For the same purpose a piece of tissue paper laid on the face of the section was often advantageous. The wax was to be removed by warming gently in turpentine, and the specimen could then be mounted in *new* balsam.

The instrument used was then minutely described. This consisted essentially of a rotating circular cutter, and a contrivance similar to the slide rest of a lathe, by means of which the thickness and direction of the sections could be adjusted, and the object advanced against the cutter while rotating. The cutter was extremely thin, and moved with great accuracy in an exact plane. This was possible, because it could be ground, polished, and sharpened on the pivots and in the position which it would permanently occupy. The slide regulating the thickness of the section could be adjusted to the $\frac{1}{10000}$ of an inch, while that which advanced the object against the cutter moved $\frac{1}{30}$ of an inch to three revolutions of the cutter, and as the latter was nearly $\frac{1}{8}$ of an inch in diameter, this was equivalent to a straight draw of three inches for every $\frac{1}{30}$ of an inch cut: this relation was attained mechanically. Great speed was not recommended. The object was supported on a little ebonite block capable of motion round an axis for the adjustment of the object to be cut in a vertical plane. The machine was of very diminutive size and delicate construction.

TO REMOVE HAIR.

R. BOETTGER states that a highly active, scentless agent for the destruction of hair is obtained by adding 1 part of crystallized sodium sulphydrate to 3 parts of precipitated chalk, and mixing in a mortar to a fine powder. The mixture keeps well in well-closed bottles; when required for use, a little is made into a paste, with water, and applied to the skin; in two or three minutes the hair is converted into a white mass, easily removed from the skin by water. By too long contact with this mixture the skin itself is attacked.

MACHINE BELTS OF HAIR.

IN engineering shops in Germany, as indeed in manufactories generally, a new kind of driving band is being adopted. It is made from hair, presumably that of the alpaca, and is delivered by the makers in a single piece without seam. It has a coating which consists principally of minium. It is everywhere spoken of as most satisfactory, and as being decidedly more durable than either gutta-percha or leather.

A NEW method of putting up jams, jellies, etc., consists in pouring them into water-proof paper bags, which are sealed, and then inclosed in stiff paste-board boxes. Said to be a cheap and effective method. George H. Chinnock, Brooklyn, N. Y.

MANUFACTURE OF ETHER.—O. Sussenguth states that the most efficacious process is to heat to 140° C. a mixture of nine parts of concentrated sulphuric acid and five of alcohol (90 per cent); as the ether formed volatilizes, fresh alcohol is allowed to stream in, so as to keep the level of the liquid constant.

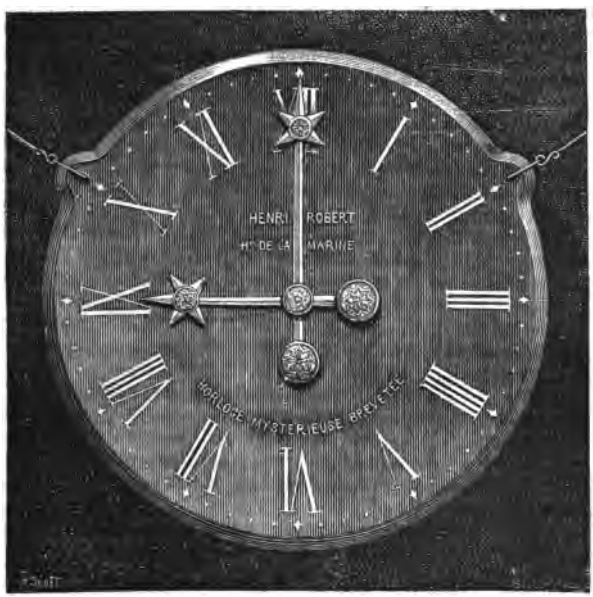
Direct firing injures the vessels used, and is apt to occasion accidents, the ether being extremely volatile and inflammable. Superheated steam is more costly, but is far safer. Iron vessels lined with lead are preferable to copper or lead-lined copper stills. The yield of ether is about 66 per cent when the operation is properly conducted—half a part of sulphuric acid for every 100 of ether being required. To obtain a good yield, the chief necessity is a constant temperature and a regular flow of alcohol.

The crude ether requires washing with water and redistillation to remove alcohol. It is possible to prepare rectified ether at one operation, however, but several practical difficulties are met with in the attempt. The vapors from the still are passed through a jacketed receiver, the jacket of which contains water at 35°; in this alcohol and water, but not ether, condense. The vapor then passes through purifiers containing quicklime in lumps and coke soaked in caustic soda and dried, so as to remove sulphurous acid. (90)

NEW PROCESS FOR COPPER ENGRAVING.—Bouquet de la Grye proposes to cover the copper plate with a thin, strongly adherent coating of silver; the silver plate is then varnished with a colored resist, and the engraving traced with a dry point; the etching is then bitten in by perchloride of iron. In this way the aquafortis process is ameliorated, since the adherence of the silver renders the graving as clean as the tracing itself; this would be a defect for portraits, but it is essential for cards.

ENAMEL FOR WATCH-FACES.—J. H. Robinson prepares these plates with a backing of sheet-iron having raised edges to receive the enamel in powder, which is fused; after cooling, the lettering and figuring is printed on the plate with soft black enamel by transferring, the plate being then again placed in a muffle to fuse the enamel of the lettering or figuring. The enamel used is composed of white lead, arsenic, flint glass, saltpetre, borax, and ground flint, reduced to powder, fused, and formed into cakes, and ground up for use.

A MYSTERIOUS CLOCK.



THE MYSTERIOUS CLOCK.

RECENTLY there has made its appearance in various jewelers' windows, clocks made of a single sheet of glass suspended from above by cords. The hour figures are marked on the glass, and the hands are pivoted in the middle of the dial; no works of any kind are to be seen, nor do the suspending cords in any wise communicate with the hands so as to suggest the idea of electricity being the motor. Our engraving shows the appearance of one of these novel time-pieces. They are of French origin.

In spite of the apparent absence of mechanism, the hands traverse the dial in the ordinary way, pointing the hours and minutes in excellent time. If touched with the finger, the hands can be swung around at will, or held still for any length of time, and on releasing them they will travel, not to the hour which it was when the derangement began, but to that which should be marked at the instant. Altogether the mechanism savors of magic, and to those who can form no idea how it operates, it seems a puzzle

not susceptible of explanation through ordinary mechanical combinations.

The arrangement, however, is really quite simple. The mechanism is in the hands, which are unequally balanced levers, the office of the clock-work being to derange the equilibrium, and so cause them to assume different positions on the pivot. This is done as follows:

The minute hand is accurately balanced on its pivot, and in the small circular box at its extremity is placed a watch movement which causes a little platinum weight to travel around within the circumference of the box. The centre of gravity of the entire hand being thus displaced by the revolution of the weight which makes one complete turn in an hour, the hand is forced to follow, and continually to adjust its position in accordance with its changing balancing point. In so doing it necessarily makes an entire revolution of the dial, and, if the time of the revolution of the weight in the box be regulated at one hour, the minute hand will complete its course in the same period. It only remains to connect the minute to the hour hand by suitable gearing to have the latter caused to move in proper manner. It is evident, however, that if the hands thus connected be deranged, only the minute hand will return to its proper place, while the hour hand will stop indefinitely.

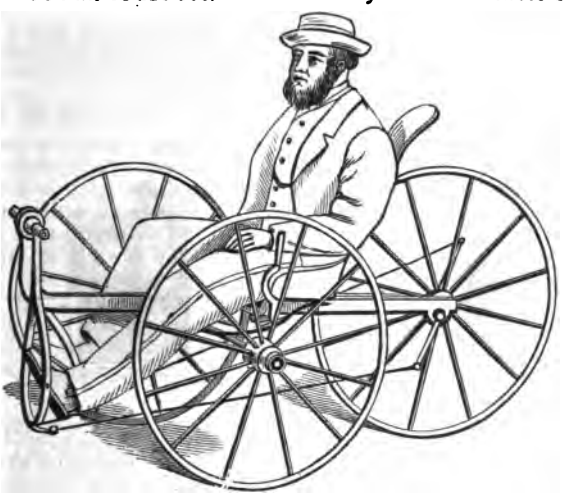
The hour hand, however, may be provided with mechanism similar to that of the minute hand, in which, however, the weight, instead of making a complete revolution in one hour, accomplishes the same in twelve hours. The hands will then have independent motions, and both, when moved will return to their positions as determined by the coaction of their contained weights.

CASTING STEEL.

E. A. COWPER introduces improvements in molds for casting steel ingots, having for their object the preparation of suitable cast-iron molds with a true, smooth, and strong internal surface. The molds are cast, whole or in segments, on chills, or on smooth and dry loam or sand molds; their surfaces being subsequently ground, if requisite, either by rotating grindstones or other like grinding wheels, or by means of fixed grinding tools attached to a bar which is caused to reciprocate to and fro, along or through any number of molds or parts of molds ranged in a row. The internal surfaces of the molds are coated with flowers of zinc, or other oxides or carbonates of zinc, applied as a paint or by subliming on to the mold, for the purpose of facilitating the removal or delivery of the steel ingots from the molds.

THE EDINBURGH TRICYCLE.

A CORRESPONDENT of the *Field* says: My tricycle weighs 83 lbs., and, when loaded for a summer journey of several days, it is made to carry myself, 196 lbs., and an overcoat, spare clothes, a book, sketch-book, colors, etc., to the extent in all of 221 lbs. I have always a comfortable seat



THE EDINBURGH TRICYCLE.

to sketch from, or to rest in when I need, with great ease in driving. You may think it hard to move such a weight as I have mentioned. Given a good road, it is not so, even up a moderate slope. The two wheels in front are acted on by the steering gear; the driving-wheel behind, the 9-inch cranks being connected by rods with treadles in front. For easier stowage in a railway car I have my driving-wheel of 36 inches only; therefore the speed is but low. Although I can put it along on level ground at the rate of eight or nine miles an hour, I seldom cover more than six in traveling; but the road must be very bad to reduce me to four.

J. FRAUENBERGER, of New-York City, has recently patented a composition for producing artificial corals, ivory, and similar articles made of caseine, mixed in the proportions described, and boiled under suitable heat, with a varnish-like solution of copal in concentrated liquid ammonia and alcohol, to be colored and prepared for the various applications in the arts.

THE WONDER CAMERA.

A "WONDER CAMERA" is a sort of magic-lantern, so contrived as to enable one to use opaque objects for projection upon the screen instead of glass transparencies. For example, if a photographer wishes to show his customer how an enlargement from a carte will look, he simply has to put the carte in the "wonder camera" and "throw it up." Many enlargement scales may be made in this way. Any person may make a "wonder camera" for himself on a plan given by Mr. T. Carter. He says:

"After experiment, I have succeeded in making the

FIG. 1.

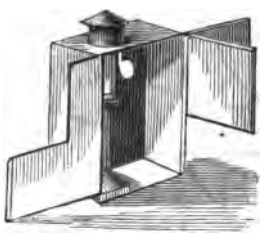
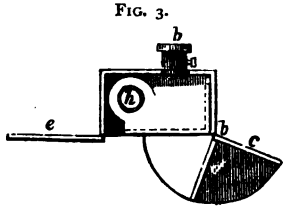


FIG. 2.

above instrument in a very simple manner. It consists of a wooden box, with a top made of tin or sheet-iron; the chimney is made of the same material. The lens is the same as used upon a camera for making photographs. At the back of the box (as will be seen by reference to the elevation and plan, Figs. 2 and 3) are two doors placed upon hinges.

FIG. 3.



"When the box is in use, the door *e* is kept closed. The other door consists of two parts placed at right angles to one another; the object of this is to fill the opening in the door *e* while the pictures are being attached to *c;* when *c* is swung into position opposite, the lens placed at *b d* is carried to one side. If stereoscopic views are to be shown, a slit may be cut at *e*, through which they may be inserted without opening the box. The door, *e*, should be cut off a little at the bottom so as to admit air. The light is placed at *h*, as nearly opposite the picture as possible. It should be a strong light; an argand burner is the best. At the back of the light is a piece of tin, bent into the form of a reflector. The light coming

from *h* strikes *c*, and is reflected through the lens upon the screen. The plan of the box is represented with the top removed. I have given no dimensions, as they will depend upon the focal distance of the lens and height of the light. Care must be used to have the distance from the lens to *c*, when closed, equal to the focal distance."

(18)

PHOTOGRAPHY IN WOOD ENGRAVING.

T. C. ROCHE covers the blocks of wood with a layer of gelatine solution of the following strength:

Water	31	grammes.
Gelatine	0.39	"

using a soft brush; a coating of the above solution is then applied in the dark after the gelatine is dry.

1. Potassium ferrocyanide	7.8	grammes.
Water	62.2	"
2. Ammonio-citrate of iron	9.1	"
Water	62.2	"

These liquors are mixed and filtered before application; the mixture should be kept in the dark. The press and blocks are exposed under the negatives from 10 to 12 minutes, and then washed with a soft sponge; the design then appears in blue. Coatings thus prepared do not shell off under the graver.

PHOTOGRAPHIC PICTURES ON PLATINUM, IRIDIUM, ETC.

WILLIS has patented a process which consists essentially in saturating paper or wood with a solution of platinum, iridium or gold salts, or a mixture of them; then drying and coating the surface with an oxalate or tartrate of iron, again drying, and exposing to light under a negative till a pale brown picture appears. By treatment with a neutral solution of potassium oxalate, the brown color is changed to deep black. The following three receipts are given:

1. The paper is treated with a solution of 1 part of potassium platino-chloride in 48 parts of water. After drying, it is saturated with a solution of 1 part of lead nitrate in 12 parts of water, again dried, and wetted with a solution of 1 part of iron oxalate in 8 parts of water, to which a little oxalic acid has been added to make the oxalate dissolve.

After drying, the paper may be exposed under a negative. The picture is floated on a hot solution of potassium oxalate, and afterward washed with a weak solution of oxalic acid, with water, with hyposulphite, and again with water.

2. Proceeding in the same manner as in the first pro-

cess, a solution of silver nitrate in 60 parts of water is substituted for the lead nitrate. After coming out of the oxalic acid solution, the pictures are dipped into a strong solution of ammonium chloride, or into a weak solution of ammonia, and finally washed with water.

3. The paper is soaked in a solution of 1 part of platinum bromide in 40 parts of water, then, after drying, in a strong solution of ferric tartrate, and again dried. The paper is then exposed to light, and the picture intensified by floating on a hot solution of potassium oxalate.

The picture is then dipped into weak oxalic acid, washed with water and dried.

NEW PHOTOGRAPHIC PRINTING PROCESS.

W. WOODBURY proposes to coat metal plates with a solution of gum, glucose, and bichromate of ammonia; when plates thus treated and exposed in the camera are breathed on, different degrees of stickiness result, so that when powdered glass or emery is sprinkled over the plate of three degrees of fineness (the coarsest being applied first and the finest last), the larger particles adhered to the more viscous surfaces, and only the smaller ones to the less sticky portions, the latter being the points where the light has acted most. The plate is then exposed to the light to harden it; an impression in soft metal is then taken; from this an electrotype can be taken possessing the grain requisite for copperplate printing.

BICHROMATE PHOTOGRAPHY.—Paul proposes to use albumen instead of gelatine in the bichromate process; a finer and more delicate picture is thus produced; cold water is used to dissolve off the unaffected part, a paper being chosen like that of the Autotype Company, which has an ivory-like smoothness and is unaffected by cold water.

VEGETABLE LEATHER.—Stœmmelen patents the manufacture of a fabric consisting of india-rubber masticated, sulphurized, and colored in the usual way; this is rolled into sheets, coiled on a drum between two cloths to prevent adherence, and then introduced into an autoclave at a pressure of five atmospheres; this steaming is continued for a time, proportionate to the thickness of the sheet. Finally, the sheet is desulphurized by means of a bath of bleaching powder, American potash, and green soap; the product constitutes a supple, elastic, impermeable material, not subject to wearing. A black tint is given by means of lampblack; a white, by zinc oxide, and so on, from 5 to 10 per cent of coloring matter being added.

ANIMAL CHARCOAL.

J. DENTON patents the use of a peculiar apparatus for treating animal charcoal, for the purpose of reburning or revivifying it. This consists of a kiln with cylindrical retorts of fire-clay, which may be glazed internally. They should be set in horizontal rows and be connected together by shoots, through which the charcoal may pass from the upper to the lower retort. Each retort is fitted with a cover at each end, the receiving end having an opening at its bottom side for discharge. In each cover, or in the covers of one of the rows, there should be a bearing for receiving a revolving spindle, and within each such retort, and supported in the bearings of the covers, is mounted a revolving shaft, and upon this shaft is mounted a series of arms, spirally, for the purpose of moving the charcoal along from the back to the front end of the retort and delivering it thence to the cooler, which may be an Archimedian screw working within a trunk. Through the hollow perforated revolving axle within the retort may be drawn by exhaustion the vapors given off from the charcoal. Instead of the hollow and perforated revolving axle and the exhausting apparatus, superheated steam may be driven through the axle, so as to mix with the vapors. Within the flues, coils of pipes for generating steam and heating air are placed, and coils of water-circulating pipes are fitted to be used in connection with the washing and purifying apparatus. In conjunction therewith, vessels are arranged for washing and purifying the charcoal, in which the water is kept at a high temperature by the circulation of hot water within a coil of pipes. Each vessel has an agitator fitted therein, consisting of a hollow shaft with hollow radial arms; and hot air or steam generated in the flues is blown through it.

VAN MONCKHOVEN'S FORMULA FOR ALBUMENIZING GLASS.—After taking glass from the bichromate solution (see preparation of glass), cover them with the following solution: Water, 4 parts; albumen, that has been beaten to a froth and decanted, 1 part. After filtering, flow the *dry* glass by means of a rod. The glass is put on a leveling stand, the albumen poured on in the centre and rapidly extended over the surface by aid of a round glass rod; then reared on end, in a place free from dust, to dry. Only an infinitely thin coating remains on the glass.

This process is particularly advantageous for large surfaces, as they are extremely difficult to clean otherwise, and besides, one can keep glass prepared in this way many months.

ABSORPTION OF ROSANILINE, MAUVEINE, ETC., BY SILICEOUS SUBSTANCES GENERALLY.

W. SKEY.—The author has shown that silica, even in the anhydrous state, and siliceous substances generally, have the power of absorbing certain organic bases from their solutions in weak acids—in fact, of acting as mordants. The same observation has been made by Reimann, who, however, states that, in the case of a compound silicate, the silica "must first be made active" in order that it may "take dyes;" and further, that free silica must be in a certain condition before it will absorb these dyes. The author finds, on the contrary, that no such preparation is necessary, but that pure quartz readily absorbs mauveine, rosaniline, and other bases from their acetates, as will also hydrous and anhydrous silicate of alumina in their ordinary state. The silicates of magnesia and lime act in like manner, absorbing also the blue dyes. Some of the bases, however, are absorbed by silicates only when a certain quantity of saline matter is present. Potash and soda felspar absorb the bases in a feebler degree, while carbonates and sulphates of lime, etc., exercise no absorptive action. Resins, fats, and paraffine absorb their bases, and stearic acid forms with them a soap, insoluble in water, but soluble in alcohol. Metallic oxides and sulphides likewise exhibit this property. In all cases the absorption appears to be wholly chemical. (2)

DECOLORIZATION OF SYRUPS, ETC.

FOURMENTIN patents the use of humus, turf, earth, etc., for the absorption of coloring matters, salts, earthy bases, etc. Filtration through such substances completely removes all color; thus 50 grammes of dry turf (employed in a moist state) will decolorize a litre of red wine. The decolorizing power of the turf is enhanced by treatment with hydrochloric acid. When mixed with slacked lime, humus-like matters spontaneously oxidize in the air, forming formiates (?).

To render turf fit for use, it should be reduced to large grains, and allowed to remain twenty-four hours in distilled or river water. After draining for twelve to twenty-four hours, it is fit for use, in the same way as animal charcoal. When saturated with coloring matters, the turf is allowed to ferment in the air; the humus-like matter thus beomes oxidized, and forms soluble compounds with the lime taken up (formiates?). The oxidized substances are treated with hot water for four days, and then with cold water containing one kilogramme of carbonate of soda per hectolitre of material to be revivified; finally they are washed with water and drained. (22)

MANUFACTURE OF CHLORAL HYDRATE.

CHLORAL hydrate is now manufactured on an enormous scale, some German makers supplying over 500 lbs. daily. Chlorine is passed into alcohol of at least 96 per cent. For 120 to 150 lbs. of alcohol the current of chlorine must be maintained for 12 to 14 days, in which time the temperature rises to 60°—75°, and the liquid acquires the density of 41° B. The crude product thus obtained is purified by heating it with an equal weight of strong sulphuric acid in copper vessels lined with lead. Considerable quantities of hydrochloric acid escape at first, and afterward chloral distils at 95° to 100°. This distillate is redistilled, collected in glass flasks, and mixed with water; and the hydrate then formed is either poured into large porcelain basins, in which it solidifies in cakes in half an hour, or it is poured into vessels one-third full of chloroform, to crystallize.

PHOSPHORIC ACID FOR SUGAR REFINING.

A. SCHEIBLER states that free phosphoric acid, if judiciously added to the syrups, does not cause inversion, while the lime present is readily removed by its means, and also some other impurities capable of being precipitated; the alkalies present are diminished (as regards their injurious action), the acids, at first combined with the lime, going to neutralize the alkalies present; the charcoal, too, is less clogged with the syrups, and less treacle is made.

The phosphoric acid is prepared by lixiviating methodically superphosphate of commerce, and adding sulphuric acid to the concentrated liquor; after straining off from the precipitated gypsum, the liquid is digested with phosphate of barium precipitated from phosphoric acid by barium chloride and ammonia; this removes any sulphuric acid or calcium sulphate present, producing in the latter case an acid calcium phosphate in no way injurious.

(22)

VARNISH.—M. Zingler patents the following process, consisting in dissolving camphor in bisulphide of carbon, mixing the solution with powdered gum copal, or other hard gum, and afterward adding either camphor or methylated spirit, or both. After the materials have been thoroughly agitated until the whole of the gum is dissolved, the product is a spirit varnish. Oil varnish is produced by dissolving linseed or other drying oil in camphor or in methylated spirits, or in a mixture of these; and this compound is mixed with the spirit varnish above described. With these spirit and oil varnishes can be mixed other gums or resins.

STRUCTURE OF COAL.

E. W. BINNEY reviews recent microscopical observations on the structure of coals. Some observers have found little else than the remains of spores and spore cases, others only scalariform and cellular tissues and a few spores, and others little trace of any structure at all; split or hard coal, soft caking or cherry coal, and Cannel coal represent these three kinds of results. Thirty years ago it was supposed that soft coals were chiefly composed of the remains of large plants, such as *sigillaria*, *lepidodendron*, etc., while caking coals are formed of plants of lesser size and much bark. The Boghead mineral is classified by most as a shale rather than as a coal, because it contains little distinctly organized matter save remains of sigillaria and other common coal plants, and is rich in inorganic matter, 25 to 30 per cent of ash being usually left on incineration.. The author believes that the yellow matter found in the vesicles of this mineral is either paraffin or an allied body giving rise to paraffin when heated; it is not found practicable to dissolve out paraffin from the mineral, however, by the aid of solvents; the more *microspores* are present in coals, according to the author's observations, the more brilliant the flame produced on burning, and the closer the resemblance in empyreumatic odor to the Boghead mineral; coals full of *macrospores*, however, only burn and smell like ordinary hard coal, thus showing that these two kinds of spores differ much in their inflammable properties, and that the production of paraffin is favored by the smaller spores and not by the larger ones.

LOSS OF COAL BY EXPOSURE TO AIR.

VARRENTRASS has made some experiments on the effects of exposure to the air on coal, which show that the loss in weight sometimes amounts to one-third, and that the loss of power is much greater even than that. The loss of weight is due to the slow combustion of the volatile parts of the coal, of which the proportion gradually diminishes in comparison with that of the carbon, ashes, and sulphur. In some of the experiments it was found that after a certain time samples of coal yielded 45 per cent less than when fresh from the pit's mouth, and had lost 47 per cent in calorific power. Other samples of the same coal, kept for the same space of time in a closed warehouse, produced only 25 per cent of gas less, and lost but 10 per cent of its calorific power. Anthracite was found to suffer from exposure to the air less than common coal, and the bituminous kinds of coal more than others.

A SCIENTIFIC TEST FOR THE DIAMOND.

A PROFESSOR, in taking leave of a pupil who was about to start for the African diamond fields, put into his hands a piece of corundum, remarking, "If you find any stone that scratches that, it must be a diamond." It is interesting to state the use made of this knowledge: the gentleman who was present at Du Toit's Pan, in the diamond fields of South Africa, and saw a bucketful of mud taken up, from which a pebble was produced; on aking leave to examine it, it was found to scratch the corundum, and $5,000 was immediately offered for it and accepted; within a week, it was sold for $30,000. Both oriental topaz, ruby, and sapphire were shown in the stone. Comparing corundum with quartz, to which it bears some resemblance, the Professor explained that they could readily be distinguished from each other; the hardness of the quartz is 7, while that of corundum is 9; and if, again, a crystal of each were broken, it would be found, while the corundum would break into rhombs on each alternate angle, the quartz would break with a curved fracture. The best way, however, of distinguishing them was to take their specific gravity, that of corundum being 3.9, while that of quartz was but 2.6.

INDIA-RUBBER SOLUTION.—Caoutchouc is well washed with water to remove dirt, and then cut under water into slices about a centimetre thick; these are pressed between rollers, and the thin sheets thus produced torn into strips and dissolved in the mixture of benzole and turpentine in the following proportions:

India-rubber	26 parts
Benzole	50 "
Turpentine	70 "

The solvents must be free from dissolved grease. Lampblack or other coloring matter can be added, if required.

PULVERIZATION OF CHLORATES. A. GAWALOVSKI.—This may be safely and conveniently effected by introducing panes of glass into a hot, saturated solution of the salt to be operated on, and scraping the fine deposit from the panes by means of a card.

The ignition of a mixture of potassium chlorate and sugar by sulphuric acid may be conveniently demonstrated by dropping it into a basin moistened with the acid.

MINERAL OIL may be detected by its property of imparting a fluorescence to animal or vegetable oils, and by its aromatic odor on burning. The presence of resin may be ascertained by its giving a deeper color with nitric acid than that given by the pure oil.

REMOVAL OF HAIR FROM SKINS.

M. ANDERSON attributes the action of charcoal as a depilatory to the effect of the oxygen condensed in the pores of the charcoal, whereby the fatty matters of the capillary glands are destroyed. If a skin covered with hair be immersed in a mixture of water and pulverized wood charcoal. all the hair is removed in four or five days. The only inconvenience which attends this use of charcoal is that the skin does not swell, so that the cleansing of the inner surface is rendered somewhat more difficult. This, however, may be remedied by immersing the skin in weak milk of lime for two or three days. When the temperature is at 15° to 20° the hair-removing effect is brought about in four to five days, but at a temperature of 5° to 10° a longer time, seven to eight days, is required.

The leather made from hides thus treated is much tougher than that made from skins treated by the ordinary lime process; less labor is required and the work is more healthy; the tanning of such skins also occupies less time, and is better accomplished, on account of the neutralization of the tanning principle through the presence of lime in the pores of the hides treated by the lime process. (90)

BLACKENING SHEET-ZINC.—The following is a new process lately discovered for obtaining zinc sheets of a solid black color. The sheet of zinc is cleansed by hydrochloric acid and sand, and then plunged into a solution of equal parts of chlorate of potash and sulphuric acid. A slight velvety-black deposit is immediately formed. The plate is carefully washed with water, allowed to dry, and then plunged into a solution of asphalte in benzine, left to drain, and rubbed with a piece of cotton rag.

COLOR PRINTING.—W. M. Halbert patents the use of papers of any of the various colors for the printing of newspapers and books from the ordinary types or stereotyped plates, with any other colored inks or liquid dyes which would contrast with the color of the paper; the letterpress being printed with the complementary color, viz.: On a red paper the letterpress is printed in green, and *vice versa;* on a blue ground the letterpress is printed in orange, and *vice versa;* on a yellow ground the letterpress is printed in violet, and *vice versa;* on a violet red the letterpress is printed in yellowish green, and *vice versa;* on a violet blue the letterpress is printed in orange yellow, and *vice versa;* on a greenish blue the letterpress is printed in reddish orange, and *vice versa.* As equal

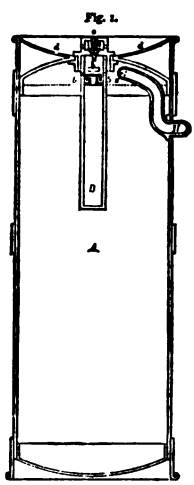
proportions of the three primary colors can produce white, black is complemental with any of these colors; therefore black grounds are used for printing with any of the other colored inks or dyes, or *vice versa*. The letterpress may also be printed on the colored grounds with acids, which would extract the color from the paper and leave the letterpress white.

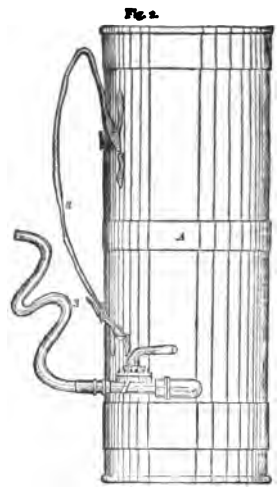
HYDRAULIC ENGINES FOR SEWING-MACHINES.—Some little engines for this purpose, made by M. A. Schmid, of Zurich, were shown at the Vienna Exhibition. They are now much used in Switzerland, where water is abundant, and supplied at a high pressure. The engine consists of a water and air-tight chest, in which works a small oscillating cylinder, the piston-rod of which turns a three-speed cone pulley. An air-vessel serves as a regulator, and a plate of plain glass in the chest permits of the working of the engine being seen. The speed of the shaft varies between 120 and 500 revolutions per minute, and the consumption of water depends on the work done. Thus, for 1 kilogrammetre, with water at 20 metres pressure, it is 360 litres (79 gallons) per hour, which corresponds to fifty per cent of useful work. For tailors' sewing-machines, which require as much power as 4 kilogrammetres per second, this engine would be much too weak, but it is stated to be adapted for sewing linen, and for family purposes. Its price at Zurich is 100 francs ($20).

ARTIFICIAL FURS.—A new method of treating fur has been patented in England, by Joseph Tussaud. He removes the hair or fur from the skin, substituting for the latter an artificial skin. First, the piece of fur to be treated is soaked in lime-water, for the purpose of loosening the hair. Then it is washed in water, and hung up to dry. Next, it is laid on a board, with the hair side up, and a solution of glue applied, care being taken not to disturb the natural position of the hairs. The glue having dried and become hard, holds the hairs so firmly as to allow the natural skin to be pulled off. An artificial skin is now applied to the roots of the hairs, by pouring over them liquid india-rubber, boiled drying-oils, or other waterproof substances, which, on drying, will form a continuous membrane supporting the hairs. The glue is then removed by steeping the fur in warm water. Furs prepared in this way are moth-proof, and superior to the natural skin for many purposes, such as mats, rugs, etc. After the removal of the hair or fur, the skins are still available for the manufacture of leather.

PORTABLE FIRE EXTINGUISHER.

ZABEL has constructed a portable fire-extinguisher, which seems to unite simplicity with great effectiveness. The apparatus, as shown in vertical section in Fig. 1, is filled up to the mouth *b* of the lead tube B with water, and





also contains some bicarbonate of soda. The lead pipe B is filled to its top with sulphuric acid (of about 80 per cent strength), with which, also, the marginal groove is provided; a lead cap set over the neck dips into the groove and excludes thus the moist air from the sulphuric acid; this precaution is required in order to prevent the absorption of moisture by the acid, for should such absorption take place, it would bring about the overflow of the contents of the lead pipe, and thus discharge the apparatus. When the extinguisher is to be employed, it is turned over, as seen in Fig. 2, several times shaken up, put by means of the strap R on the back, and then discharged through the tap H. On inverting the apparatus the little lead cap falls off, the sulphuric acid pours into the water, which fills the interior of the cylinder, decomposes the bicarbonate, and thus saturates the water with carbonic acid gas and sulphate of soda. The quantity of bicarbonate taken is such as to yield carbonic acid capable of producing a pressure of $4\frac{1}{2}$ to $5\frac{1}{2}$ atmospheres. The apparatus is proof for a pressure of 14 atmospheres.

IMPROVEMENT IN PEAT MANUFACTURE.

THE peat is first heated by coils filled with superheated steam stirred by the machinery, and after the water has escaped so far heated that part of the pyroligneous and tarry products of the wood fibre are developed, which then serve as a cement when the powerful hydraulic pressure is applied. The whole operation takes only thirty minutes, and is a striking illustration how mechanical art can perform in a short time a transformation which it took nature millions of centuries to accomplish in our coal-beds, which are nothing but vegetable, peat-like remains of vegetation changed by pressure and more or less heat into the different qualities of coal.

VARIABLE HOSE-PIPE NOZZLE.—Captain William Leggett, of New-York city, has designed a nozzle for hose-pipes, so constructed that the fireman holding the pipe in hand, may readily enlarge or diminish the size of issuing stream of water. It is a simple and beautiful improvement, highly approved by the various fire departments, and is rapidly coming into general use.

THE CHEMISTRY OF STEEL.

BY PROF. B. S. HEDRICK.—Prof. Baur, of New-York, found that chromium was a steel-making element, acting like carbon. It was formerly supposed that silicon must be entirely burned out of the iron in the manufacture of steel. It is now found that silicon is also a steel-making element when made to take the place of carbon. Professor Du Motay, of France, has lately shown that phosphorus is a steel-maker. Boron and aluminium can be put in the same list. Thus substances which have heretofore been regarded as highly injurious can be used in the manufacture of true steel, if the carbon is removed and the proper quantity of the other be substituted. The paper was discussed by Professors J. Lawrence, Smith, Hunt, Silliman and Johnson. Professor Smith gave his experience with reference to cast-iron containing phosphorus as better resisting the effects of strong acids. Professor Hunt stated that wrought-iron having as high as one per cent of phosphorus shows a remarkable power in resisting friction, as in sleigh runners, instancing the use of this iron from a noted foundry in Canada. Professor Johnson remarked that titanic iron ore found in the Adirondacks is wonderfully free from phosphorus, sulphur and other impurities, although the manufactured iron contains no trace of titanium, and the process of reducing the ore is too expensive for the profitable working of mines in that locality.

INTERNATIONAL RIFLE CONTEST.

A TRIAL of skill between six riflemen of America and six from Ireland, made near New-York. 1874, ended in a victory for America, the shooting on both sides being marvelous for accuracy. Two hundred and seventy shots (fifteen for each man at 800, 900, and 1,000 yards respectively) were fired on each side; and four points being given for each bull's-eye, the possible total was 1,080 to each competing team. The Irish party marked 931, and the Americans, previously to the last man's shot, exactly tied them. Colonel Bodine was firing, and on him depended the result. He scored a centre, 3 points, making a total of 934. We believe this total has never been exceeded. But the equality of the two scores was even more remarkable than this, as the Irish side lost four points by one marksman firing at the wrong target, on which he made a bull's-eye.

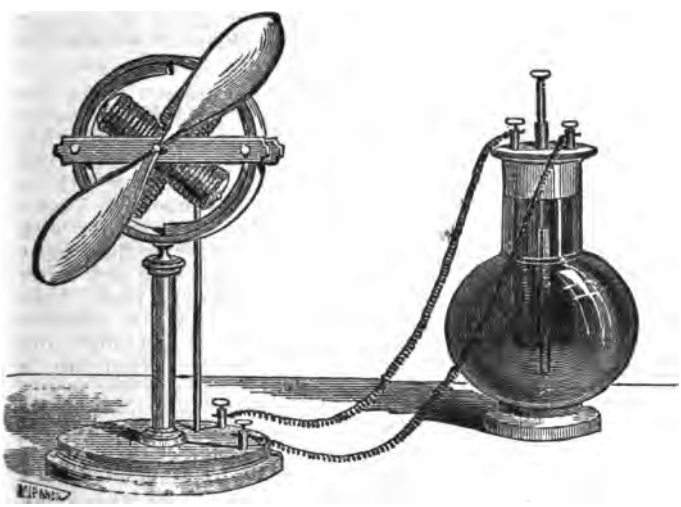
ASBESTOS.—G. Cleghorn and F. G. Paterson make the following application of asbestos: 1. Making paper out of asbestos fibre pulp, or mixture of that with other fibre and cutting this asbestos paper into strips, and twisting these into thread, yarn, or cord, either with or without being first coated with india-rubber. 2. Twisting two or more of these into larger cords, either with or without a core of india-rubber, for making fluid-tight packings and joints of stuffing-boxes, working and other parts of steam-engines, and other machinery, pipes, boilers, stills and retorts. 3. Plaiting these twisted asbestos threads into braids for making the said packings and joints. 4. Weaving the asbestos thread or yarn into a cloth, somewhat about the texture of canvas which would withstand the action of the weather and heat, and be used for flange joints and for coverings, mail and dispatch-bags, window-curtains, also for producing works of art upon surfaces to stand against decay and fire, and making wrappers for projectiles. 5. Making waddings, cartridge cases, and wrappers for cartridges out of asbestos paper, millboard, pasteboard, or woven fabric, which would prevent windage and friction, from the flexibility and lubricity of the asbestos, enabling the barrels to be kept longer clean and be fired oftener.

REFLECTION OF CRYSTALS OF COPPER SULPHATE.—If a large clear crystal of copper sulphate is held near a polished plate of platinum or steel in direct sunlight, it is seen that whenever the rays are reflected from the crystal on to the plate, the latter appears of the color of copper.

ELECTRICITY, LIGHT, HEAT, SOUND.

THE AERIAL SCREW.

UNDER this name, M. De Fonvielle has constructed an apparatus for testing the powers of various electric batteries. Using a winged screw, in the form of a ship's propeller, he is enabled, by counting the rotations, to ascertain accurately the power of any motor which he may ap-



ply to it. Our engraving shows clearly the manner of its use. With a screw of 12 inches diameter and a motor of three magnets weighing about 2 lbs. each, a speed of rotation of 5 turns per second was obtained from a battery equivalent to 6 Grove's elements. The speed can be minutely and precisely adjusted by varying the battery power, and experiments on the size and pitch of the blades of propellers can be readily made.

NEW DIAL TELEGRAPH.

MR. S. M. YEATES, philosophical instrument maker, in Dublin, has invented a modification of the step-by-step telegraph. In all alphabetical telegraphs hitherto made it is essential that the operator should always move the handle round in one forward direction, and therefore, if a letter be required which precedes the one last indicated, it is necessary to carry the pointer all the way round the dial, in order to indicate the letter required.

In Mr. Yeates' new instrument both the transmitting and receiving instrument work backward or forward indifferently, and therefore—in the case supposed of the word "day"—the operator, having moved the index to D, has only to move it back to A and then back to Y, thus transmitting the word with only eleven contacts, instead of forty-nine, as in the other case. The great advantage gained by this will at once be seen: First, it greatly increases the speed of the instrument; and secondly, it greatly lessens the chances of tripping.

The action of both the receiving and transmitting instruments will be best understood by reference to the cuts.

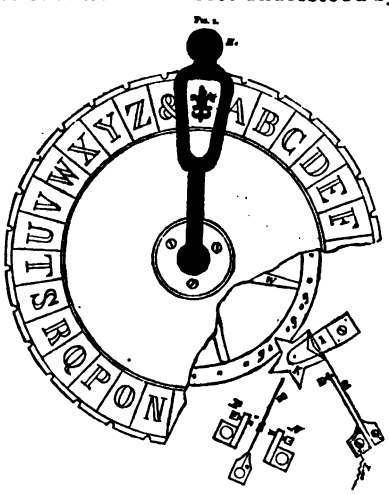


FIG. 1.—YEATES' NEW DIAL TELEGRAPH.

Fig. 1 is the transmitter part of the dial, being removed in order to show the arrangement of contact. Suppose the handle H to be moved towards the letter A; it carries with it the wheel W, and the pins, *g g g*, in its edge, come in contact with the wheel K, and, moving it round, causing one of its teeth to press against the spring S, and form contact with the stud N, thus closing the circuit, and sending out a *negative* current which passes through the right-hand magnet of Fig. 2 (the receiving instrument), and causes its index to move toward A also. A similar action takes place when the handle is moved in the opposite direction; only in this case the spring S is pressed

against the stud, P, thus sending a *positive* current, which passes round the left-hand magnet of the receiver, and thus makes the index move toward Z on its dial.

It will be observed that when the handle of the transmitter is on a letter the spur-wheel K has one of its teeth midway between two of the pins, *g g*, in W; it is kept in that position by the spring R. The action of R is as follows: When the pin, *g*, pressing against the tooth of K, causes this wheel to turn round until one of its teeth, sliding along one of the inclines of R, arrives at the point where the two inclines meet; then the spring comes into full play on the opposite side of the tooth, and carries K the remainder of the way, so that the pins in W only move K half of a tooth, and R moves it the other half, and it is while it is passing through the second half-tooth that contact is made between the spring S and the studs P or N. In this way it is not possible for the operator to make a false contact, or cause the index of the receiver to move while hesitating between two letters, as would occur in any other form of alphabetical telegraph.

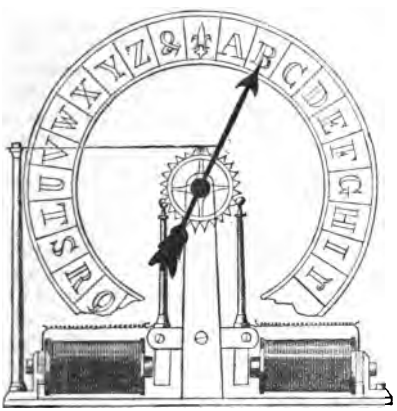

Z & A B C D E F G H I J
X Y Z & A B C D E F G H I
W X Y Z & A B C D E F G H
V W X Y Z & A B C D E F G
U V W X Y Z & A B C D E F
T U V W X Y Z & A B C D E
S T U V W X Y Z & A B C D
R S T U V W X Y Z & A B C
Q R S T U V W X Y Z & A B

FIG. 2.—YEATES' NEW DIAL TELEGRAPH.

A CHEAP GALVANIC BATTERY.

MR. W. M. SYMONS proposes a cheap but convenient galvanic battery: each of the zinc plates was two inches square, and covered with fustian or other fabric, outside which copper wire was wound to form the other plate; the exciting liquid was weak chloride of zinc. Pairs of plates thus made could be arranged in series to form a battery to give out weak currents for a great length of time.

THE perturbations produced in the mariner's compass by the rolling of the vessel have been theoretically investigated by Sir William Thomson, who concludes that it may be found necessary to use at sea long needles whose vibration period amounts to fifteen or twenty seconds.

NEW TELEGRAPH INSTRUMENT.

A NEW invention in telegraphy, by George B. Prescott and Thomas A. Edison, has lately been successfully tested at the main office of the Western Union Company in this city. The new invention is a process of multiple transmission, by which two messages can be sent simultaneously in the same direction over the same wire, and either message can be dropped at any way-station on the circuit. The old duplex system can be applied to the new invention, and by the combination four messages can be sent simultaneously over the same wire in opposite directions between any two terminal points. The old Morse key is used, with no duplication except as to parts of machinery. It is alleged that the invention will quadruple the usefulness of the 175,000 miles of wire now owned by the company.

A NEW THEORY OF ELECTRICITY.

PROFESSOR EDLUND, a Swedish physicist, expounds in a recent work a new theory of electricity, the substance of which is as follows: He supposes the existence of a highly subtle and elastic ether, everywhere present, both *in vacuo* and in ponderable matter. Two molecules of this ether are mutually repelled along the line of their connection and in inverse ratio to the squares of the distances. In good conductors, the molecules are displaced easily from point to point, it being presumed that they can be moved with little force. If the body be a non-conductor, this mobility is arrested and depends on the molecules of the material body. A molecule is at rest from the moment when it is equally repelled on all sides. If the repulsion be less at one side than at the other, the body will move if it be free in the direction of the resulting forces.

BUNSEN'S BATTERY IMPROVED.

AN improvement suggested by JamesPool consists in filling the porous cup around the carbon with coarsely powdered (it should be powdered about as fine as gunpowder) graphite, which is a hard substance obtained from the inside of gas-retorts. The battery is set in action by moistening the powder with nitric acid, which is done by pouring a few spoonfuls into the porous cup. I have found, he says, that the current developed by this arrangement will be sustained for a long period of time, while its intensity is equal, if not superior, to that when acid alone is used. The poisonous vapor arising from the battery is very little, owing to the small quantity of acid employed.

NEW ELECTRIC CLOCK.

AMONG the many objects of interest in the recent Art Exhibition of Dundee, few things excited more interest among the visitors than a clock worked by electricity, in connection with a normal or master clock by Messrs Ritchie & Sons, of Edinburgh. The master clock, which is one merely of an ordinary kind, requiring to be wound up periodically, is placed on the platform of the large hall. The oscillations of its pendulum are used to complete contact between the poles of a galvanic battery on the top of the clock-case. There are two cells of the ordinary Daniell's sulphate of copper battery, one pole of each being placed in metallic connection with the gas-pipe, and the other pole terminating in a slender spring, against which the pendulum-rod impinges; and while contact is thus obtained alternately with one or other spring, a current of positive or negative electricity is sent through the pendulum-rod, along the insulated wire connected with it, to the other end of the hall, where the sympathetic clock is placed. This differs from previous electric clocks, and is provided with a magnetic pendulum, consisting of a wooden rod having a hollow coil or bobbin of insulated copper wire, the ends of which are attached to the suspension springs on which the pendulum is hung. A double bundle of permanent magnets is fixed in the centre of this bobbin, their similar poles being placed toward each other. An attraction to and repulsion from the poles of the magnet hung in the centre of the coil is caused by the passage of the currents of electricity through the wire coil of the pendulum, in which motion is thus produced and maintained. The makers have constructed a simple but effective escapement, or rather propelment, by which two arms are alternately raised by the pendulum out of action with the record wheel of the clockwork, and when released, by mere force of gravity, push forward the wheel-work and hands by sudden and decided steps, which are thus registered by the hands of the clock. There is such a peculiarity in the construction of the pallets that no probable force can push forward the hands beyond the fixed stops, and no power less than the weight of the gravity arm will drive the wheel-work backwards.

The difference between this system and that which works electric clocks hitherto in use, is that the passing currents of electricity are employed merely to maintain motion in the pendulum, which is effected by a very weak battery; and from the great momentum, these currents may be intermitted or the wire cut for even two minutes

at a time without destroying the coincidence of time shown by the sympathetic clock, which is dependent on the motion of its own pendulum, and not in any way upon the power of the battery. This allows the opportunity of causing several clocks attached to the same wire circuit to report their accuracy by making each clock at a certain second to cut the wire connection during that second, and thus the flow of the current is prevented. By means of a galvanometer placed in the wire these dropped seconds are observed, and the correctness of the respective clocks guaranteed. Whatever the number of clocks placed on the same wire circuit, all of them will, of course, act in unison with the beat of the normal or master clock.

(61)

THE CAMACHO ELECTRO-MOTOR.

SEVERAL scientific men, at Havana, have been appointed to examine the electro-magnetic engine invented by J. S. Camacho, and to report on its advantages for industrial purposes in general, and especially as motive power. So says the *Revista de Telégraphos*. In the Camacho electro-magnet each limb is formed of four hollow concentric iron cylinders, the inner one half an inch in thickness, and the three remaining one-quarter inch. The interior diameters of the tubes are respectively, 2, 3, 4, and 5 inches. Each of them is surrounded with a coil of copper wire, covered with cotton, and is one-eighth inch in section, forming, on the three inner tubes, two complete layers with 180 turns, and on the outer tube seven layers with 630 turns.

The copper wire on each tube is coiled in the same direction, passing at its ends across the armature of the magnet, and uniting them, therefore, in the natural order, so as to form a single conductor through which the current from the battery may travel, magnetizing each tube, and endowing them all with magnetism of an equal nature. The length of the limbs of the magnet is 8 inches, the weight 77 lbs., and that of the copper wire 47 lbs., with a total length of 2,600 feet.

Repeated experiments have shown that this magnet requires the current produced by seven bichromate of potassa elements, and its power of attraction at a distance of one-twelfth of an inch is more then 1,250 lbs. An electro-magnet of the ordinary construction, of equal exterior diameter, and placed in the same conditions, is only able to support 25 lbs., a weight 50 times smaller.

Repeated experiments of physicists, as eminent and well versed in electro-magnetism as De la Rive, have shown that the main difficulty which has opposed the industrial application of the electro-magnetic force has been

that hitherto it has proved from 25 to 30 times dearer than that of steam.. If, therefore, M. Camacho has succeeded in obtaining electro-magnets so powerful, the following proposition can not be pronounced too venturesome: "The new electro-magnets offer to industry a source of power much cheaper than animal labor, and capable of immediate application to urban railways. The same power is further destined, at no remote epoch, to replace advantageously that of steam."

The report is signed by D. Francisco Clerch, Professor of Physics and Chemistry at the College of Guanabacoa; D. En. de Aranlave, Inspector-General of Telegraphs for Cuba; D. Antonio de Molina, Engineer-in-Chief on the staff of the roads, canals, and harbors, and of public works; and D. Alberto de Castro, Civil Engineer.

THE LAWS OF FRICTIONAL ELECTRICITY.

M. L. JOULIN has investigated the laws of frictional electricity with a machine suggested by the electrical phenomena often observed in bells used for transmitting power. A very great quantity of electricity is thus produced, capable of giving long brushes and sparks, of deviating a galvanometer needle, of decomposing water, and in Geissler tubes of showing the stratification of the light. A new method of measuring electric tension has been employed, dependent on the greatest distance at which a brush is perceptible on a given sphere when brought near the electrified body. The experiment was varied by using pulleys of various metals or non-conductors, and by changing the velocity, tension, and temperature. In arranging the results there seem to be three causes influencing the production of electricity—the velocity of separation of the parts of the belt and pulley, the complex mechanical action of bending the belt, and the temperature of the two materials.

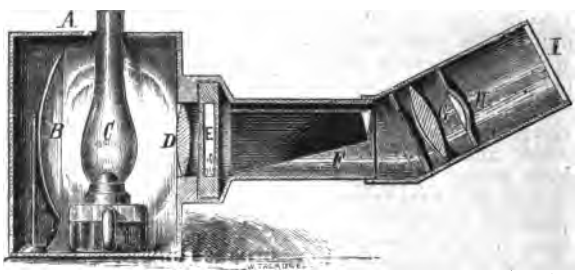
NEW GALVANOMETER.

DR. FRIEDRICH MULLER describes a new form of galvanometer, with improved reading and deadening arrangements. The needle is immersed in glycerin diluted with one-eighth of water, and above it there is a horizontal tube of glass in rigid connection with it, to which the suspending thread is attached. Platinum wires, bent vertically upward from the ends of the tube, are in a plane with the suspending thread. And the zero point of a scale, seen beyond, is in a line with these three parts when the needle is in its normal state of rest. (88)

M. NEYRENEUF has ascertained by experiments that negative electricity attracts flame, which positive electricity repels.

THE KALEIDOGRAPH—A NEW OPTICAL INSTRUMENT.

THE want of a ready and non-expensive means of exhibiting to several spectators at one and the same time the beautiful and ever-changing combinations of color and form presented by the kaleidoscope has long been felt. The power of arresting the progress of these changes at any given point, so as to admit of copying such combinations as might be thought worthy of reproduction as



artistic designs, has also been a desideratum. The "kaleidograph" seems destined to supply the want so long felt. This instrument consists of a magic lantern fitted with a reflector, B, in front of which is placed a kerosene lamp, C.

The light produced by the lamp, and thrown forward by the reflector, passes through a condenser, D. Directly in face of the condenser is affixed a tube, furnished with a transverse aperture, E, to admit of a slider, containing pieces of colored glass, lace, etc., and also fitted with two plane glass mirrors, F, inclined at a proper angle to one another. To the end of this mirror tube, is a second tube containing a double convex, G, and a meniscus lens, H, and placed at an obtuse angle to the plane of the first tube. The lenses in this second tube receive the reflected images from the two silvered mirrors, F, and project them on a little ground-glass screen, I, which is attached to the extreme end of the tube. The rotation of the little glazed box, containing the pieces of glass at E forming the kaleidoscopic image, is effected by means of a cranked handle actuating a rack and pinion; the motion can be arrested at any point which may be rendered desirable by the appearance of a beautiful or peculiar combination of colors and forms. The inventor and patentee of this very ingenious instrument is Mr. Osgood Pritchard, of London, England.

NEW CAMERA LUCIDA FOR DRAWING.

IT is known that the construction of the *camera lucida* is founded upon the simultaneous perception of two images—that of the object and that of the pencil. Various means have been employed to arrive at this result. In that of Sömmering, it is a metallic mirror smaller than the pupil; that of Amici is constructed on the principle of reflection on a plate with parallel faces; that of Wollaston, at present most in use, consists in a prism, of which the edge, dividing the pupil in two parts, permits the object to be seen by the upper half, and simultaneously the pencil by the lower portion. In all these systems the fusion of the images is somewhat difficult to seize, especially for certain points of the reflected image. Govi, Professor of Physics at the Royal University at Rome, proposes to cover with a thin layer of gold the reflecting surface of a prism, and to apply upon this, with Canada balsam, a second prism with like angles. Although this layer of gold is sufficiently transparent to allow the luminous rays to pass, its power of reflection is considerable, and it gives images of great brightness. We have thus a perfect means of superimposing, without fatigue to the eye, two different images—the one direct, and the other reflected. The principle is the application of that property of thin plates—metallic or otherwise—to transmit simultaneously direct rays, and to reflect rays which arrive obliquely from another source.

NEW SPECTROSCOPE.

THE instrument is the invention of Professor A. K. Eaton, of Brooklyn, N. Y., and is by himself named "a direct-vision spectroscope." It consists of a thick plate of glass with parallel sides, united to one of the faces of an ordinary bisulphide of carbon prism, or a prism of dense flint glass. According to the amount of dispersion desired, the light is made to enter either on the end of the glass plate, or on the opposite face of the bisulphide prism. The results obtained from this instrument are as follows: The dispersion of this compound prism is nearly four times greater than that of the ordinary 60° prism. The mean emergent ray is practically parallel to the incident ray. It does not deflect the ray from its original path. Many Fraunhofer lines are visible by this prism with the naked eye, while with the observing telescope all the prominent lines are clearly reversed, without the use of the slit or collimeter, by merely throwing a strong beam of light by means of a mirror.

When the usual appliances of slit-collimeter and tele-

scope are employed, it widely resolves the D line, and shows the nickel line between these two lines—a result claimed as the best obtained by a four-prism instrument of Browning.

It is stated that a simple bisulphide prism in this instrument gives a dispersion of 40° between the B and G lines; when it is used for projection, it gives a spectrum 8 feet long at a distance of 10 feet from the screen, enabling 100 dark lines to be counted.

It is evident, therefore, that this prism promises to become a most valuable instrument for projection in the lecture-room, while either solar, electric, or oxyhydrogen illumination may be employed, having the great advantage of simplicity of adjustment, since it avoids the necessity of turning the lantern after the slit has been focussed on the screen.

NEW SPECTRUM RESEARCHES.

DR. HENRY DRAPER, of the New-York University, communicates the highly valuable results obtained by himself in attempting to photograph the diffraction spectrum of the solar light. The photographs published by him are of remarkable clearness, and must be considered as an important advance over the spectra that have hitherto been drawn by the hand alone. In the finest maps drawn by hand, such as those of Angström, the relative intensity and shading of the lines are but partially represented, and a most laborious and painstaking series of observations and calculations is necessary in order to secure approximately correct positions of the multitude of Fraunhofer lines. Thus, for instance, Angström in a certain portion of his spectrum shows 118 lines, while Draper's photograph gives 293. The diffraction plate used by Dr. Draper was prepared for him by Mr. L. M. Rutherford, by a machine devised and constructed by that well-known amateur. It consists of a plain glass surface, a portion of which, equal to about one square inch, is ruled with a fine diamond point with 6,481 lines to the inch. Owing to the fineness of details brought out by Draper's photographs, he is justified in the statement that the exact composition of even a part of the spectrum of any metal will not be known until we have obtained photographs of each on a large scale.

SULPHATE OF COPPER OPTICS.—If we receive the solar light reflected by a large crystal of sulphate of copper upon a sheet of platinum or tin plate, placed at a small distance from the crystal, the sheet assumes the color of metallic copper upon the part which receives the reflected light.

MID-AIR SPECTROSCOPIC OBSERVATIONS.

IN a balloon ascent recently made for scientific purposes by Messrs. Croce-Spinelli and Sivel, the authors ascended to a height of about 22,000 feet, experiencing a temperature at that elevation of 7.6° Fahr. Spectroscopic and physiological observations were particularly attended to. It was noted that of the two obscure bands on the right and left-hand of the double line D in the solar spectrum, the right-hand band disappeared at an elevation of about 16,000 feet while the left-hand band vanished at about 21,00 feet, thus confirming Janssen's opinion that these bands are of terrestrial origin. The observers carried with them cans of condensed oxygen, and found some relief from the effect of the rarefaction of the air by breathing that gas.

POWER OF RED RAYS ON SELENIUM.

M. SALE, in experimenting on the electric conducting power of selenium, which varies with the degree of light to which it is exposed, as described in our RECORD for 1874, says that, after careful experiments, he concludes that the effect of the light is not produced by the chemical rays, since the maximum of diminution is observed in the maximum point of the red rays. Neither is the change in the resistance due to an augmentation in the temperature. While the effect also of the light is sensibly instantaneous, the return of the selenium into its normal resistance after the light is cut off is not so rapid. Finally it appears that there exists in the red rays, which are the most intense in heating properties, a power which, without modifying the temperature, changes the molecular conditions of the particles.

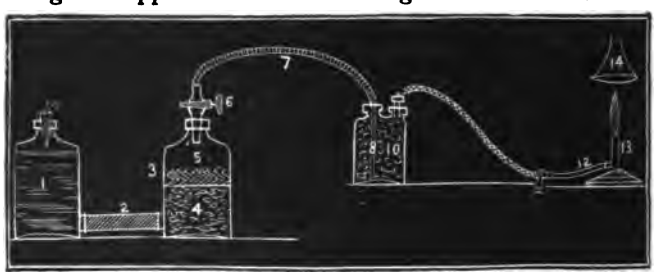
REFLECTING POWER OF FLAME.

RECENT experiments by M. Sorel prove that carbon retains its reflecting capacity even at the highest temperatures. A sunbeam becomes reflected by diffusion and is polarized in exactly the same manner, whether it falls upon a brilliant flame or upon smoke.

PRODUCTION OF LIGHT IN STONES.—When various kinds of hard stones are pressed by the workmen (with their hands) against quickly-revolving grindstones, the transparent stones become pervaded throughout with a yellowish-red light, like that of red-hot iron. Opaque stones give a red light at the place of contact, with halo and sparks. Dr. Nöggerath thinks the phenomenon worth studying by physicists.

A NEW ARTIFICIAL LIGHT.

THE new light is formed by a gas composed of bisulphide of carbon and binoxide of nitrogen. It possesses many advantages, among which the following may be named: 1. It is under the complete control of the operator. 2. The eye can support its rays without fatigue. 3. It is not intermittent like the electric light, nor liable to spontaneous extinction like magnesium. 4. It is cheaper and more easily procured than any other artificial light known, and any skillful person can, at a small expense, arrange the apparatus and make the gas in his studio.



E. Stebbing describes the apparatus as follows: No. 1. A seven or eight-quart bottle containing a mixture of nitric and sulphuric acid. No. 2. A strong india-rubber tube, twenty inches long. No. 3. A bottle of equal proportions with No. 1, filled half-way up with broken pieces of chinaware, No. 4, on the top of which are laid pieces or small jars of wrought-iron, No. 5. No. 6. A tap strongly fastened in the neck of bottle No. 3, in order to regulate the flow of binoxide of nitrogen gas. No. 7. India-rubber tube, at the extremity of which is a glass tube, No. 8. This tube, joined to the tap, puts in communication bottle No. 3 with bottle No. 9. No. 9. A two-necked quart-bottle filled with pumice-stone or coke, broken into pieces about the size of a large pea, impregnated with bisulphide of carbon, No. 10. The glass tube No. 8 must descend to within a quarter of an inch of the bottom. No. 11. A metal tube, ten inches long, into which is crammed, or rather rammed, iron turnings, these serving to prevent explosions. No. 12. India-rubber tube connecting tube No. 11 with lamp No. 13. No. 13. Lamp made with a three-eighth brass or iron tube, and five inches in length; at about an inch from the bottom is screwed a smaller tube, to which is attached the india-rubber tube No. 12. No. 14. Chimney to receive the gases formed by the combustion, which are very pernicious.

To employ the apparatus, fill the bottle No. 1 with a mixture of nitric and sulphuric acids, in the proportion of one of sulphuric to two of nitric acid. Take the cap out of the neck of bottle No. 3; the acid will then find its way into the bottle containing the broken chinaware and the fragments of wrought-iron by the india-rubber tube No. 2. The formation of the gas will then take place more or less rapidly, according as the bottle is raised or lowered, No. 1 containing the acid. The tap is now put into its place, taking care that no gas escapes.

The pressure of the gas formed in the top of bottle No. 3 will drive all the acids into bottle No. 1, and the formation of the gas will cease. If you now open the tap No. 6, the gas will naturally rush through the india-rubber tube into the bottle containing the coke or pumice-stone impregnated with the sulphide of carbon; the gas then makes its way by the tube filled with iron turnings, No. 11, and the india-rubber tube, into the lamp No. 13, the orifice in which must not be diminished in size. It would be well to place a tap between the tubes Nos. 11 and 12, in order to regulate with more precision the flow of gas to the burner.

Photo-portraits may be taken, and printing, etc., done with this light.

Great care must be taken in the employment of this gas; for an explosion is to be feared unless proper precaution be taken to prevent its escape.

If a considerable quantity of the gas be required, it is easy to construct a gasometer, and, instead of employing iron in the generator No. 3, bars of copper can be used, which are attacked by the acid with greater rapidity than the iron. The gas can be preserved for a long period without losing any of its properties. (1)

NEW ELECTRIC LIGHT.

INTERESTING experiments with MM. Ladygin and Kosloff's electric light were lately conducted at the engineering works of Messrs. Warner, Euston Road, London. To obviate the difficulty of carbon being consumed when burnt in contact with oxygen, M. Ladygin placed sticks of carbon in a closed glass chamber filled with a gas not containing oxygen; but owing to the use of metallic connections, the carbon was subject to fracture. M. Kosloff succeeded in overcoming the difficulties by using a special metal of which he forms the holders for the carbon rods, and these are placed in the closed glass chamber.

The lamps which were experimented with were nine in number, six of them having two carbon rods, either of which could be placed in connection with the current of electri-

city. The carbon rods were all three-quarters of an inch in length, and one in each lamp was one-twelfth of an inch in thickness, the others being a trifle less in thickness. The other three lamps contained each a carbon rod, three inches in length, one-twelfth of an inch thick, and also connected with the main current. The first experiment consists in burning a carbon rod in contact with the atmosphere, the rod being consumed in a few minutes. The current was then turned on the thicker rod in each of the six lamps, and a brilliant and steady light was produced, which improved as the current was increased in intensity. The reason for lighting the thicker rod first was that it might consume the oxygen in the lamp, by which the rod was slightly reduced. The current was then directed through the second rod with equally satisfactory results in all the six lamps. The three lamps with the longer carbon rods were then lighted and successfully exhibited, changes being frequently from the six to the three lamps and back again. The apparatus used for producing the current was Gramme's magneto-electric machine. With the machine running at about 200 revolutions a minute, a moderate light was obtained, which was greatly improved at 300 revolutions, the maximum of intensity being obtained at 450 revolutions. The strength of the light depends upon three things—on the power of the machine and the number of its revolutions, on the length and thickness of the carbon rods, and on the quality of the carbon. The experiments showed that, with the same strength of current and the same number of revolutions, double the amount of light was obtained with three long carbon rods, as compared with the six short ones. The experiments demonstrated satisfactorily the fact that the electric current could be subdivided, and hence, if practice confirms experiment, which it is believed it will, there is a wide field open for the application of Kosloff's system. (101)

CAUSE OF PHOSPHORESCENCE OF DECAYING WOOD.

It is stated that the attempt to account for the phosphorescence of decaying wood by the assumption of a peculiar process of combustion accompanying decay has lately been rendered unnecessary by the discovery of the presence on such wood of a fungus which emits light, as a result of vital processes, and which, without destruction of this power, can be scraped off and transferred to other wood; even animal matter may be rendered phosphorescent by it. High temperature or gases that destroy life, as well as the withdrawal of the requisite degree of moisture, cause instant cessation of the light.

PHOTOGRAPHY AT THE BOTTOM OF THE SEA.

DR. NEUMAYER has recently exhibited before the Berlin Geographical Society a photographic apparatus, designed for the determination of the temperature and of the currents at great depths in the ocean.

The invention is composed of a copper box, hermetically sealed and furnished with an exterior appendage made like a rudder. In the interior is a mercury thermometer and a compass, each inclosed in a glass receptacle in which are admitted traces of nitrogen gas. A small electric battery completes the apparatus. When the latter is allowed to descend attached to a sounding-line, the action of the current on its rudder causes it to assume a parallel direction, thus indicating the set of the flow by the relative position of compass, needle, and rudder. The thermometer of course shows the surrounding temperature. In order to fix these indications, a piece of photographic paper is suitably disposed near the glass cases containing the instruments. Then at the proper time a current of electricity is established through the gas in the receptacles, causing an intense violet light, capable of acting chemically upon the paper for a sufficient length of time to allow of the photography thereon of the shadows of the compass-needle and of the mercury-column. Within three minutes, it is said, the operation is complete, when the apparatus is hoisted and the paper removed.

THE MAGNETIC EQUIVALENT OF HEAT.

THERE has recently been devised, by M. Cazin, in France, a thermo-magnetic differential apparatus, by means of which, it is stated, the absolute quantity of heat engendered by magnetism may be measured; in other words, the magnetic equivalent of heat may by its aid be determined. The investigator, after observing the thermic effects of magnetism on the core of a rectilinear electro-magnet, around which the wire is rolled in alternately opposite directions, so as to produce several poles, enunciates the following law: "When the alternate spirals constructed by the wire have the same dimensions, and when they divide the magnet into several equal portions (*concaméerations*), the quantities of heat created in the iron core at the opening of the voltaic circuit are inversely proportional to the squares of the number of divisions, the other circumstances not changing." For example, four similar bobbins are disposed around a cylindrical iron tube at equal distances apart, the tube extending a short length beyond the outer coils. In establishing the communications, there is obtained, with the same total length of wire

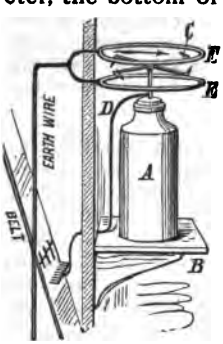
and the same total number of points, one, two, or four divisions: the quantities of heat decrease as the numbers, $\frac{1}{1}$, $\frac{1}{4}$.

In order to measure this heat, M. Cazin has constructed a kind of differential air thermometer, in which air reservoirs are used. Two or three thousand interruptions of the electric current produce, with an ordinary battery, a calorific effect very plainly measurable. By dividing the pressure observed by the number of interruptions, and making a small correction analogous to that employed in calorimetry in taking account of the cooling action of adjacent bodies, the thermic effect of the magnetism is obtained.

AN ELECTRICAL BAROMETER.

MR. EDWIN LEACH, Superintendent of the Singer Sewing Machine Company, New-York, has made the following simple device to exhibit the electricity of running belts in machine shops, and to produce ozone thereby:

A is a vial, about 6 inches in length by 1¼ inches in diameter, the bottom of which is inserted in a cavity in the bracket, B. In the centre of the cork is inserted the eye end of a darning-needle, the point projecting upward about 2 inches, on which rests the wheel, C, which consists of two pieces of copper wire, 1-32 inch in diameter and 7 inches in length, placed at right angles to each other; their centres are flattened and soldered together, and half an inch of the end of each arm is bent at a right angle, all in the same direction, and filed to a point. D is a copper wire, one-eighth inch in diameter, one end of which rests against the needle, the other running in front of and about 6 inches distance from the belt, and terminating in 5 or 6 points, 2 inches long, projecting toward it. E F, copper wire coils; 5½ inches diameter, one above, the other below the wheel, at a distance of 1 inch. Both coils unite with a line leading to a gas pipe or other earth conductor. The device may be placed on a shelf in the office, or elsewhere, at a distance from the leather belt.



When the air is dry and frosty, says Mr. Leach, I have had it running as fast as 280 turns per minute, and the ozone given off by the wheel is apparent to the senses at a distance of several feet. It also acts as a barometer, in-

dicating (by increasing or diminishing its speed) atmospheric changes several hours in advance. It is especially lively on the approach and during the prevalence of a northeast snowstorm; but with the wind anywhere from east to south, it will scarcely move at all.

The apparatus can be easily constructed by any person of ordinary intelligence, and it makes a very interesting scientific apparatus. It can as well be located in the counting-room, or office, as in the engine-room.

HEAT CONDUCTIVITY OF CRYSTALS, ROCKS, AND OTHER BODIES.

E. JANNETAZ has shown that in cleavable crystals, heat is most readily conducted in directions parallel to the cleavage-planes, and considers that the directions of easiest cleavage are those of greatest reticular density.

The author has now experimented on a considerable number of schistose rocks, and with the invariable result that on the lamination faces the isothermal curve is a circle, while on a section perpendicular to the cleavage planes the form is invariably an ellipse, with the major axis parallel to the traces of the lamination. The general law appears, therefore, to be, that heat is propagated most easily along the surfaces which have the least mutual cohesion.

HEAT PHENOMENA.

SOME very curious phenomena have been observed by Tresca during the forging of the great ingot of platino-iridium. When it was at a dull red temperature, one could observe upon the sides of the ingot luminous streaks accompanying each blow of the hammer. These brilliant streaks continued sufficiently long to allow six different ones, developed by six successive blows, to be simultaneously visible. Tresca affirms that the zone which becomes luminous is that along which the molecules flow when the change of form consequent upon the blow takes place.

THE OHM.—The term "ohm" is derived from the name of the celebrated electrician who first ascertained the laws of electrical resistance, and is a measure of resistance of which it is the unit, in the same way as we use the inch or yard in the measure of length. The "ohm," as a unit of resistance, was adopted by a committee of the British Association many years ago, and is now the acknowledged standard of resistance throughout the world. The ohm represents the resistance of about 210 feet of copper wire No. 16, or galvanized wire No. 8, unexposed to disturbing causes and in a temperature of 60° Fahr.

EXPLOSIONS PRODUCED BY SOUND.

THE paper recently read by Mr. William Galloway, Inspector of Mines, before the English Royal Society, is a valuable and important contribution, marking, we trust, the beginning of further investigations into the prevention of the accidents and large loss of life in mines, due to explosions of fire damp.

Mr. Galloway conceived the idea that a sound wave, originated by a blown out shot, in passing through a safety lamp burning in an explosive mixture, would carry the flame through the meshes of the wire gauze in virtue of the vibration of the molecules of the explosive gas; and to test this view, he instituted a series of experiments under the auspices of the Royal Society, which adduced perfectly conclusive results.

A glass tube 3 feet 4 inches long and 3¼ inches in diameter, was placed horizontally with one end opposite the flame on the same side of the wire gauze, and distant from it about 1¼ inches. At the other end of this tube, a sound wave was produced by exploding a mixture of coal-gas and oxygen contained in bubbles. When the sound wave passed through the tube, the flame was carried through the gauze and ignited the gas in the Bunsen burner on the other side. Paper and other diaphragms, inserted at a distance of 10 feet from the origin of disturbance, insured that only the sound wave was propagated through the tube.

More elaborate apparatus was then constructed, so arranged that the sound wave of a pistol shot was conveyed through tin plate tubes to a distance of about 20 feet, where it passed through a safety lamp burning in an explosive mixture. The Davy, Clanny, Stephenson, Mueller, and Elvin lamps were all tested, with, however, the results that, while the flame passed easily through the Davy lamp, it passed with more difficulty through the Clanny, and not at all through any of the others.

After this, experiments were made on a larger scale in a sewer, where it was found that 109 feet was the greatest distance a sound wave could be propagated of sufficient intensity to pass the flame, when caused by the discharge of a pistol loaded with 59 grains of powder. The sewer was built of brick, and was 6 feet high by 4 feet wide.

Mr. Galloway's discovery, that when the vibration of the air which constitutes a sound wave has a certain amplitude, it can transmit flame through the wire gauze of the Davy and Clanny lamps, furnishes an additional argument against trusting the lamps in use among ordinary workmen.

THE STEAM SIREN.

FOG signals, many of which are required at different points on the Atlantic and Pacific coasts, are of several kinds. Some are steam-whistles, the sound of which is made deeper or louder by being sent through a trumpet; but the most effective is probably the siren. This ingenious machine consists of a long trumpet and a steam-boiler. The sound is produced by the rapid revolution past each other of two flat discs pierced with a great number of small holes; a jet of steam under high pressure is projected against the discs, which revolve past each other more than a thousand times a minute; as the rows of small holes in the two discs come opposite each other, the steam vehemently rushes through, and makes the singular and piercing noise which a siren gives out. One of these machines costs about $3,500 complete, with its trumpet, boiler, etc.

REMEDY FOR REVERBERATION.

THERE are few things more provoking than the inability to hear a public speaker distinctly, when that inability arises from the fact that the building has been constructed with little or no regard to good acoustic effect. Plain and parabolic sounding boards have been introduced, but with very indifferent results. Drapery has been festooned about the sides and bases of the arches with no better (and with very unsightly) effect; and until quite recently, no really successful method has been devised by which the difficulty could be overcome. The Rev. Joseph P. Taylor, formerly rector of St. Paul's Church, Brunswick, Me., ascertaining that his audiences were greatly troubled to hear him distinctly, on account of excessive reverberation, gave the subject careful investigation and study, and conceived the idea of overcoming the difficulty by the introduction of screens of very fine wire beneath the ceiling, at a proper angle and at such a distance from the pulpit as would best intercept the sonorous wave, and thus prevent its striking the reflecting surface with sufficient force to cause echo. The same device was subsequently employed by Mr. Taylor in the Brown Memorial Church, Baltimore, where a very bad echo or reverberation existed; and the testimony of prominent men connected with the church is that the cure is complete. The Asylum Hill Congregational Church, of Hartford, Ct., has been successfully treated on the same plan. The wires are of very small gauge, and do not disfigure the church in the least. A stranger would not notice them unless his attention were particularly directed to them. The result of the experiment is most satisfactory, and the hearing is

equally good in all parts of the house. The wires are so placed as to receive the sound-wave before it reaches the reflecting surfaces which cause the reverberation. The sound impinges against the wires; its force is broken, and it has no power to produce an echo or reverberation from the surfaces beyond, nor is the sound reflected back by the wires to the audience. It is simply broken, and its force is taken up by the wires, which, by inaudible vibrations, convey it away.

MUSIC BY TELEGRAPH.

MR. ELISHA GRAY, of Chicago, a gentleman we.. known as an inventor and manufacturer of telegraphic apparatus, has perfected an instrument by which sounds produced at one end of a wire can be conveyed to the other end by electricity, over circuits of great length. It has been tested upon the wires of the Western Union Telegraph Company over a circuit of 2,400 miles, with the most satisfactory results. Tunes, played upon the keyboard of the transmitting portion of the apparatus, were distinctly audible and unmistakably reproduced, note for note, at the distant end of this long circuit.

The apparatus has been named by Mr. Gray the telephone. The transmitting apparatus consists of a keyboard having a number of electro-magnets corresponding with the number of keys on the board, to which are attached vibrating tongues or reeds, tuned to a musical scale. Any one of these tongues can be separately set in motion by depressing the key corresponding to it. To this transmitting instrument the conducting wire is attached, the other end being attached to the receiving apparatus, which may be anything that is sonorous so long as it is in some degree a conductor of electricity. A violin, with a thin strip of metal stretched between the strings at a point where the bridge of the instrument is ordinarily placed, will, on receiving the sound transmitted through the conducting wire from the piano, give out a tune very similar in quality to that of an ordinary violin.

MEASURING DISTANCES BY SOUND.

MAJOR DE BOULENGÉ, of the Belgian army, has recently devised an instrument for the above purpose, which he calls a battle telemeter, and which appears to give remarkably accurate results. The apparatus consists of a glass tube having graduations along its length representing distances measured. The tube is closed at its extremities, and is filled with liquid in which is a metallic traveler, formed of two discs united by a central rod. The diameter of the discs is a little less than that of the tube,

so that, when the latter is vertical. the traveler will descend with a slow and uniform motion. A brass covering protects the glass, and has a slit through which the scale and traveler can be seen. Knowing the velocity of sound and that of the traveler, it is easy to construct the distance scale.

In operation, the edge of one disc is brought to the o mark; and the instrument being held horizontally, the flash of the cannon, for example, is noted; at that instant the telemeter is turned to a vertical position, and so held, the traveler, of course, descending meanwhile until the sound is heard, when it is again brought horizontal. The position of the traveler denotes the distance to be read on the scale.

It is stated that, during the course of official experiments at the Belgian Artillery School, the instrument, in estimating distances of 3,200 yards, did not make over 21 yards of error, a quantity certainly insignificant when other causes of irregularities in firing are taken into consideration.

The force of the wind is said to have but little effect in impairing its accuracy, and the error due to temperature may be corrected by using as the fluid a mixture of alcohol and water in proper proportions.

THE PYROPHONE.

M. FREDERIC KASTNER, of Paris, has recently devised a novel and very remarkable musical instrument, which, it is said, produces astonishing effects even in the midst of the largest orchestras. It is termed by its inventor the pyrophone, and we present herewith an engraving of it, taken from *La Nature*. The origin of the device is due to the curious discovery made by M. Kastner in the properties of singing flames. Many scientists have studied these interesting phenomena, but the peculiarities of two flames in conjunction seem to have escaped their notice.

As a result of his investigation, M. Kastner finds that if, in a tube of glass or other suitable material, two or more isolated flames of proper size be introduced and located at a point corresponding to one-third the length of the tube, reckoning from the base, such flames will vibrate in unison. The phenomenon continues as long as the flames remain separate, but the sound ceases the instant they are brought in contact.

The pyrophone, at first sight, resembles an organ; but instead of being operated by air blown in, it produces its notes by the singing of the flames within the tubes, the quality of the sound, its pitch, and intensity depending, of course, on the dimensions of the latter. The burners from

which the flames emerge are so arranged that the flames run together, but may be separated instantly by pressing down a key on an ordinary key-board, seen in front. The position of the key in relation to the sound is the same as upon the piano or organ. According to the law above cited, as soon as the key is pressed, the separated flames, in the corresponding tube, give forth a note, continuing, as in the organ, as long as the key is held down.

It is said that the music thus produced is extremely beautiful, and that the sound closely resembles, in delicacy and purity, that of the human voice.

APPLICATION OF WIND TO STRINGED INSTRUMENTS.

MR. BAILLIE HAMILTON lately described, before the Physical Society, an attempt to excite stringed instruments by blowing, instead of scraping or twitching, the strings. He found that if a reed were attached by means of a metal pin to some part of the length of a string fixed at both ends as usual, the reed and string would accommodate themselves to each other and vibrate together, the string separating into two unequal segments; the segment connected with the reed being always shorter than the other or reinforcing segment. This last, indeed, takes the place of the column of air in an organ pipe. Some strings so mounted were sounded by wind, and gave a very good tone, closely resembling that of an organ pipe.

Mr. Hamilton considers that he has thus combined all the advantages of stringed instruments with all the advantages of reed instruments, and has obtained thereby a very perfect and pure source of sound. The compass he has already secured is about seven octaves. The excursions of the reed are so restrained by its connection with the string that it produces no perceptible harshness. Any difficulty there may be about delay in speaking, can be got over by percussion as usual; but the author finds that an elastic band stretched across the nodal points of the whole set of strings, not only steadies them, but transmits a thrill from any one in vibration to the rest, just sufficient to make them respond immediately when a key is depressed.

In order to avoid the usual defect of strings, namely, their liability to get out of tune, Mr. Hamilton flattens the part of the wire beyond the bridge and coils it into a light spiral; this entirely prevents changes of pitch as the string expands, and indeed renders very considerable rotation of the tuning-pin necessary in tuning them. His bass strings consist entirely of these flattened coiled wires; a very great length of wire being thus comprised within a

comparatively short length, the tones of a grand piano can be obtained with a very moderate length of sound-board. Some such coiled strings were struck and gave wonderfully fine bass notes.

MAGNETIC CONDENSATION.

IT is well-known that a bar of soft iron, surrounded by an induction coil of wire, becomes magnetized on the passage of a current through the latter. Large magnets are frequently thus constructed; and in one capable of sustaining 320 lbs., M. Lallemand has noticed a curious condition. He states that, after allowing the above weight to be supported by the magnet, he removed all but 110 lbs., and then interrupted the current. The weight, however, remained supported, as it appeared, by residual magnetism in the iron. On removing the armature and weight, and then trying to replace the armature, it was found that the magnetism in the bar had disappeared, and that there was not sufficient to hold the armature alone. *La Nature* mentions this as a new discovery, and suggests experimenting them. In this view our contemporary is at fault, as a well-known electrical expert informs us that, in using large magnets, he has repeatedly remarked the same phenomenon, and is, besides, under the impression that even a greater proportion than one-third the weight can be sustained by the residual magnetism left in the bar. The explanation is doubtless to be found in the rearrangement of the atoms of the iron under the influence of the current, a condition which, though, of course, not visible, can nevertheless be made to demonstrate its presence, as Professor Tyndall has shown, by a click at the establishment and interruption of the electric flow. The magnet and its armature and weight thus form a circuit, which may be likened to a band of steel held in annular form. The atoms retain their altered places even after the stoppage of the current; but the instant the continuity of the ring is broken, they return to their normal position, just as do the particles of steel when strain is removed.

LIME DEPOSITS IN WATER-PIPES.

MM. FABRE AND ROCHE point out that wherever there is a joint in water-pipes, made to connect tin conduits or copper faucets, at such points carbonate of lime is most abundantly deposited. If a piece of silver be placed inside in contact with the lead pipe, it becomes covered with the carbonate in a very short time. The investigators find that all metals, electro-negative with relation to lead, are thus affected. A voltaic couple is in fact formed, and a veritable chemical precipitation caused.

ELECTRIC RESISTANCE OF SELENIUM.

THE Earl of Rosse, operating with a bar of selenium 2¼ inches long, verifies the recently announced fact of the diminution in the electric resistance of crystals of selenium when exposed to light. He obtains in some cases a diminution amounting to 38 per cent of the total resistance, and his experiments demonstrate that the effect is not due to radiant heat, or at least not to such dark heat rays as are emitted from a vessel of hot water, or to those calorific radiations from a luminous body which are absorbed by a solution of alum in a glass cell. He finds that the effect is proportional to the length of the bar on which the light is suffered to fall. A remarkable result of which the experimental figures are given, is that the decrease of the electric resistance is by no means proportional to the intensity of the light, being nearly in the inverse ratio to the simple distance of the selenium from the source of light, and therefore approximately as the square root of the luminous intensity. Some variations of the effect observed and described by the author he is disposed to connect with the deposition on the selenium of films of moisture and their subsequent evaporation.

ELECTRIC DISCHARGES IN AIR.

BY allowing a series of sparks from an electro-magnetic induction apparatus to be discharged between platinum electrodes in perfectly dry air, Boettger noticed the formation of yellow vapors, and after the lapse of a few minutes, nitrous acid was recognized by the smell. If the sparks are passed through very moist atmospheric air, or if the sides of the glass vessel in which the experiment is conducted are moistened with distilled water, and some is allowed to collect at the bottom, no yellow vapors are formed; but the air, in a few minutes, acquires the characteristic odor of ozone, while in the water the presence of hyponitric acid can be detected. Iodide of potassium and starch paper, the test in common use for the detection of ozone in the air, is thus shown to be an untrustworthy reagent, as it must in many cases turn blue by nitrous acid. It behoves meteorologists, now that their attention has again been directed to these facts by Professor Boettger, to ascertain the exact condition of moisture under which the acid is produced, and to establish a process for the estimation of ozone which shall be of absolute certainty.

Dr. Dotch, of New-York, who has for years occupied himself with the artificial generation of ozone, states that strips of paper saturated with the tincture of guaiacum

afford a more sensitive and certain reagent or test for the presence of ozone than either the iodide of potassium and starch or paper containing protoxide of thallium; and that such an ozonometer can be relied on to show at least 10 gradations or shades.

ELECTRICITY PRODUCED IN MECHANICAL ACTIONS.

CERTAIN phenomena of electricity of tension, observed in leather-belting by M. Joulin, have recently been the means of directing the attention of that physicist to the subject forming the above heading. He has constructed machines in which the mechanical tension of the belt can be varied at will, and has used for conducting pulleys the following materials: Iron, brass, zinc, red copper, white iron, lead (the last four metals applied in thin laminæ to wooden pulleys); the imperfect conductors, walnut wood, leather, hardened rubber, in sheets of 0.36 inch, applied to wood; cloth and silk fastened in form of cushions, also to wooden pulleys.

In the machines formed of metal and leather, in the latter body electric tensions of surprising intensity were found. Independently of the long sparks obtainable, a metallic wire brought near the belt was traversed with a continuous current powerful enough to deflect the needle of a galvanometer, with electricity of tension to weakly decompose water, and in slightly modified Geissler tubes to produce a distinct stratification of the electric light. The circumstances influencing the electric production may be referred to three causes: separation, more or less rapid, of the bodies; the complex mechanical action of incurvation, depending, in the case of leather, on the elastic state and dimensions of the pulley, and the number of incurvations in a given time; lastly, the common temperature of the two bodies, or that of one of them.

GALVANIC ELECTRICITY WITHOUT CHEMICAL ACTION.

AT a recent meeting of the Physical Society, Mr. Fleming showed his new battery, in which the metallic contact of dissimilar metals is entirely avoided. The arrangement consists of thirty-six test-tubes of dilute nitric acid, and the same number of tubes of sodium pentasulphide, all well insulated, alternating with one another. But strips of alternate lead and copper connect the neighboring tubes, by which means the terminals are of similar metal, and a current of sufficient intensity to violently affect a quantity galvanometer obtained. The potential increases, as in the ordinary galvanic arrangement, with the

number of cells employed, until sixty cells showed an electro-motive force exceeding that of the same number of Daniell's elements. In this new battery the acid lead is positive to copper, while in the sulphide it is negative. Mr. Fleming further showed how, by using the single fluid nitric acid, and the single metal iron, a similar battery could be constructed, provided one-half of each iron strip was rendered passive. This is an important discovery; for it seems to revive the theory that chemical action is not necessary in a galvanic apparatus to produce electricity.

ELECTRICAL CURRENTS FROM ALBUMENOID SUBSTANCES.

M. BECQUEREL has shown that, when two heterogeneous liquids are separated by an organic membrane or by a capillary space, they give an electric current capable of producing chemical and mechanical effects, reduction of metals, and double decomposition, etc. M. Onimus finds that the interposition of a layer of albumenoid matter (white of egg, albumen of blood) has the same electro-chemical results. Thus, with the solutions of sulphate of copper and of oxalate of potash, separated in a tube by albumenoid substance, beautiful blue crystals of oxalate of copper and potash are obtained. The phenomena, he points out, may throw light on the formation of phosphate of lime in animals.

MAGNETIC CONDENSATION IN SOFT IRON.

BY A. LALLEMAND.—Magnetic condensation, first discovered by M. Jamin in steel, takes place also in soft iron with a very remarkable strength and persistence. Let a horse-shoe electro-magnet be formed of an iron cylinder, 4 c.m. in diameter, and round each branch let a wire spiral, 2 m.m. in diameter and 150 m. long, be wound; the armature to be a plate of soft iron, 2 c.m. thick and 4 c.m. wide. When the double helix is traversed by a current from a single Bunsen element, feebly charged, about 150 kilos. (330 lbs.) may be supported: on breaking the circuit 50 kilos. (110 lbs.) may still be supported; but, after the armature is detached, all trace of magnetism disappears, and the electro-magnet will not even attract its armature.

But this relation is variable, depending on the strength of the current, dimensions, and form of the contact piece, and nature of the iron of which the magnet is formed. The persistence of the condensed magnetism is most remarkable, for after twenty days the magnet continued to support 50 kilos., and on then detaching the armature the same value, 182, was given.

THE GRAMME MAGNETO-ELECTRIC MACHINE.

THE invention of M. Gramme, now regarded as the most economical magneto-electric machine in use, was first produced in 1871. Since that time it has been greatly improved. In our SCIENCE RECORD for 1874, we figured and described some of these improvements. The characteristic feature of this important invention lies in the disposition given to the armature. Round a ring of soft iron is wound a number of equal lengths of insulated copper wire, and a movement of rotation is imparted to the whole, when a current of corresponding strength is induced in the revolving helices. This peculiarity of construction will be understood by referring to Fig. 1, which is a section of the annular core. It shows several segments of the covered wire with the free ends projecting from the ring. These are attached to copper strips R, which, in turn, are in electrical communication with copper sectors R, fixed on the spindle of the machine. The two ends are connected with two consecutive axial conductors, while the lengths themselves are insulated from one another by layers of silk. Each coil of the wire thus appears like an element of a battery yielding its contribution to the aggregate current. M. Gramme has changed several parts, and varied the disposition of others, so that the machine of 1874 differs in several important respects from previous devices.

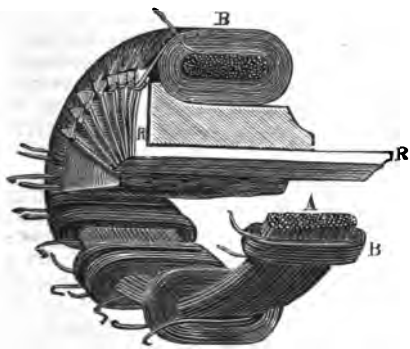


FIG. 1.—GRAMME ELECTRIC MACHINE.

In the earlier machines there were two or three movable armatures, according as they were constructed for light or for metallurgical purposes. One of these was used solely for making the electro-magnets, while the other, or others, produce the useful current. In the new machine there is but one armature, differing only in size from the former ones. There is the same way of winding the wires in insulated sections, and of collecting the current on the spindle by means of metallic brushes. There are only two electro-magnets, and they are fixed horizon-

tally in the cast-iron uprights. Semi-circular segments of soft iron project from the poles of the electro-magnets, and almost entirely clasp the armature. There is always an amount of remanent magnetism in these which suffices to induce a current in the helices as soon as they begin to revolve. The current, feeble at first, becomes very powerful by being transmitted round the electro-magnets, in consequence of their reaction on the annular armature. These electro-magnets are now made to form a part of the circuit, whereas in the former machines they were merely used as a magnetic magazine, and consequently required a separate current.

These modifications greatly simplify this beautiful magneto-electric apparatus, without in the least diminishing its power. On the contrary, it is found that the speed of

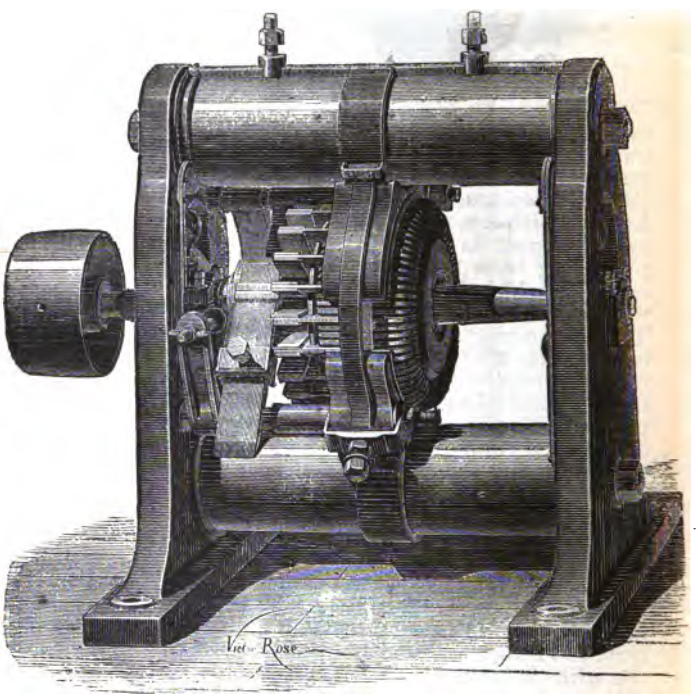


FIG. 2.—GRAMME'S NEW ELECTRO-PLATING MACHINE.

rotation may now be raised from 300 to 500 revolutions per minute without occasioning any inconvenience, while a current is evolved proportionally stronger. No sparks have been observed at the contact of the metallic brushes, and no increase of temperature has been noticed, either in the ring or in the electro-magnets. This is of primary importance, because the sparks are injurious to the machine, and the internal resistance rises with every increment of heat.

The new machine, as constructed for electrotyping establishments, is shown in Fig. 2. Its weight is 390 lbs. The wire on the armature and the electro-magnets weighs

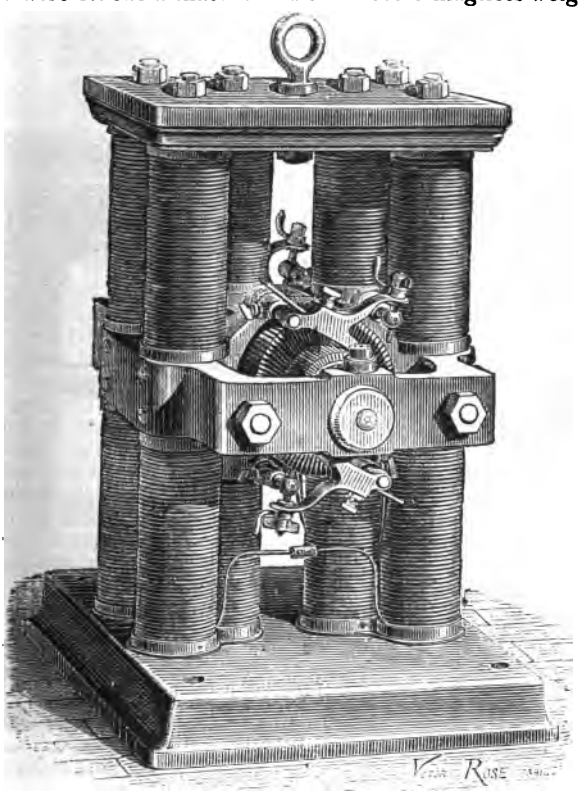


FIG. 3.—GRAMME'S NEW ELECTRIC-LIGHT MACHINE.

103 lbs. It is 21.5 inches long, and 23.5 inches high. At its normal speed, it deposits 21 ounces of copper per hour. It thus requires less room than that of 1872; its weight is reduced three-fourths, the copper is but little over one-fourth the quantity formerly used, and there is an economy of 30 per cent in the driving power, while electrolytic deposit remains the same in quantity and quality.

These very dispositions give rise to an electrical phenomenon, which must have occasioned some embarrassment in the beginning. While the armature was in rapid motion, the current flowed on uniformly in the same direction; but it was observed that whenever it was stopped, either accidentally or voluntarily, a secondary current of inverse direction was produced. The poles of the electro-magnets were instantly changed, thereby reversing the direction of the armature current. It followed, unless the conductors were also reversed, that whatever electrotyping process was carried on before, would now be partly undone. This phenomenon might have been expected from the introduction of the electro-magnets into the circuit; for, by the simple principle which underlies all magnetic induction, an inverse current must have been produced as soon as the rotation ceased, as may easily be shown by Faraday's celebrated experiment of 1832. To meet this difficulty, M. Gramme has devised a little appendage which automatically interrupts the current as soon as the speed of the armature has reached a certain minimum. This is effected by a small piece of metal, similar to an ordinary keeper, and carrying a counterpoise. This circuit-breaker, if we may so call it, connects the brushes with the electro-magnets. So long as these are strongly magnetized, they overcome the weight of the counterpoise, and retain the circuit-breaker in contact with them; but when the speed of the armature has fallen to its minimum, their feeble attractive power is insufficient to equilibrate the opposing weight, and the circuit-breaker is detached, disconnecting at the same time the armature and the electro-magnets. The secondary induction currents are prevented, and consequently the poles of the magnet remain unchanged.

In order to show more forcibly the effects of all these modifications, M. Gramme took one of the earlier machines and made the required alterations. Instead of its usual 21 ounces of silver, it now deposits 74 ounces per hour. We may add that Messrs. Christofle & Co., of Paris, impressed by such results, have ordered six of the new machines for their Paris establishment.

M. Gramme has also devoted his attention to the light

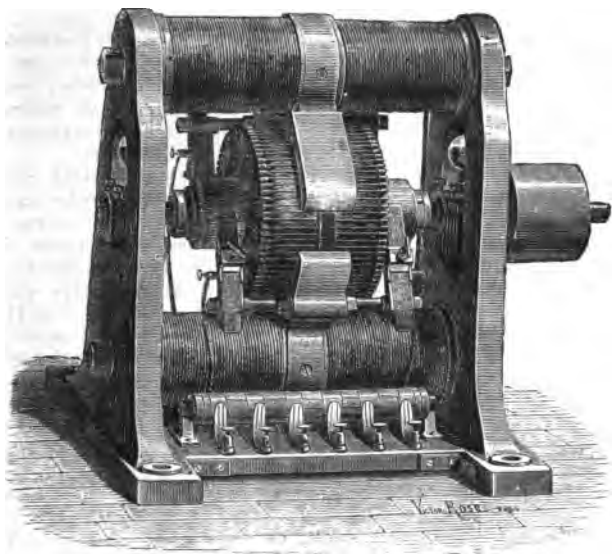


FIG. 4.—GRAMME'S NEW HORIZONTAL ELECTRIC-LIGHT MACHINE.

machine. The new apparatus, Fig. 3, differs from the old one chiefly in its size, which is smaller, and also in the disposition of the electro-magnets. Instead of being placed in a straight line, these are now arranged in the form of a triangle. In this special form of the apparatus the two armatures are still retained, and matters are so contrived that the current may be used for one or for two lights simultaneously; or again, the current from one armature may be transmitted round the electro-magnets, and that from the other used externally. This machine weighs 1,540 lbs., its height is 35 inches, and depth 25 inches. The wire of the electro-magnets weighs 396 lbs., and that round the armatures 88 lbs. It produces a normal intensity of 500 Carcel burners, which, however, may be nearly doubled by increasing the rapidity of rotation. When the current is admitted through two regulators, each one gives a light equivalent to 150 Carcels.

This improved apparatus has been further modified. The latest form is identical in appearance with that used for electrotyping purposes; that is, there is only one armature revolving between the elongated poles of an electro-magnet. It is shown in Fig. 4. It may be observed

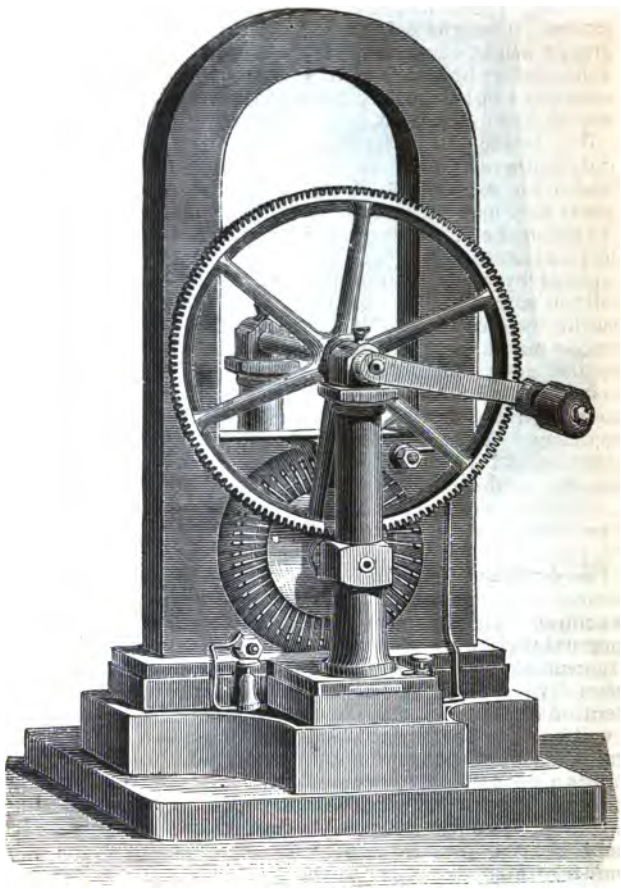


FIG. 5.—GRAMME'S SMALL ELECTRIC-LIGHT MACHINE.

that the number of coils is great, as this is necessary in order to obtain tensional effects. It will also be noticed that there are two sets of current-collectors on each side of the poles. Two distinct currents are thus obtained, which, by means of the longitudinal cylinder placed at the base of the machine, may be connected together for quantity or tension, as the case may require. It is also found that this disposition has the additional advantage of con-

tributing to prevent the occurrence of sparks at the collectors. It weighs 402 lbs.; the covered wire has an aggregate weight of 104 lbs. It is 22 inches in length and width, and its height is 24 inches. It produces at 900 revolutions a light equal to 200 burners; but this intensity may be much increased.

But, beside these large light-machines, M. Gramme makes others of only 50 or 100 burners. These are intended for workshops, foundries, halls, etc., in which places they may be used with decided advantage. There is a yet smaller type, specially constructed for the laboratory and lecture table. In these the electro-magnet is replaced by a permanent magnet, which is placed vertically in some, and horizontally in others, as shown in our RECORD for 1874. M. Breguet, who constructs these smaller machines, has introduced a further modification by the adoption, Fig. 6, of M. Jamin's new magnet, as in Fig. 5, which gives better results than the ordinary steel magnet, diminishing at the same time the cost of the apparatus. An engraving and description of the construction of this remarkable form of permanent magnets was also published in SCIENCE RECORD for 1874.

All these machines afford a very striking instance of the transformation of energy, viz., of motion into electricity, and conversely, of electricity into motion. This latter may easily be shown by connecting the two collecting brushes with a galvanic battery. As soon as the circuit is completed, the armature begins to revolve with a speed proportional to the strength of the current. This same experiment may also be repeated, and with enhanced effect, by means of two of the educational machines just mentioned. If they are placed so as to form one circuit, it will be seen that by rotating one armature, the second one is set in motion and reciprocally. If the direction of rotation be suddenly reversed, the second armature will suddenly stop, and almost directly recommence revolving in the opposite direction. Another very striking experiment bearing on this subject, is made by introducing a length of platinum wire into the circuit. While the two machines are in motion the temperature of the platinum is not affected; but if one be stopped by an attendant, the wire is raised to a red-heat, thus rendering visible the mutual convertibility of heat, motion, and electricity.

Another useful application of this machine is the transmission of energy from one place to another situated at a considerable distance. This is effected by connecting the two machines by thick wires, or, better still, by a metallic cable. The loss of force will depend upon the resist-

FIG. 6.—GRAMME'S SMALL ELECTRIC-LIGHT MACHINE, WITH JAMIN MAGNETS.

ance of the conductor. Several experiments of this kind have been made with interesting results.

It may also be interesting to observe that, as a very small motive power equals a large number of voltaic cells, so a considerable number of the latter would be required to produce a small amount of mechanical work. This is well illustrated by the following experiments, which were made with quart-size Bunsen elements, and a small machine mounted with Jamin's magnet.

Number of Cells.	Number of Revolutions of the Armature.	Force in Foot-Pounds.
2	760	2.2
3	810	7.3
4	1000	11.4
4	900	12.9
5	1100	18.0
6	1000	24.2
7	1100	29.8
8	1100	36.0
8	900	34.6
9	1500	36.7
10	1700	39.6
10	1300	44 6

We can not conclude without referring to another small machine constructed by M. Gramme. The armature is bound with two wires of different gauge, and is moreover provided with two sets of collecting brushes. By this arrangement a quantity current proceeding from a battery is readily converted by the apparatus into another of high tension. This modification might be turned to account for telegraphic purposes; but the idea does not seem to have been practically carried out yet. (28)

ELECTRIC CURRENTS BETWEEN LIQUIDS.

WHEN two heterogeneous liquids, says M. Onimus, are separated by an organic membrane or by a capillary space, an electric current is caused, which is capable of producing chemical and mechanical effects. Reductions of metals and double decompositions, which do not take place under ordinary conditions, may be so obtained. In many cases the interposition of a layer of albumenoid substance (white of egg, blood-albumen, etc.) between two liquids will produce similar electro-chemical phenomena. If a solution of albumen be poured into a U-tube so as just to cover the bottom, and solutions which react on each other be carefully poured into each side, it will be found after some time that the solutions will meet in the albumen and give rise to double decomposition. If sodium phosphate be placed on one side and calcium nitrate or chloride on the other, calcium phosphate will be obtained on the side where the sodium phosphate has been placed. In medicine, it may therefore be more useful to administer these salts separately, rather than calcium phosphate directly, since the latter salt can be readily produced in the system. Whilst neither calcium chloride nor sodium phosphate coagulates albumen, a very manifest coagulation takes place where the double decomposition is effected. The coagulation is probably due to electro-molecular currents; for it ensues on that side only which may be considered as the positive pole. When the coagulation prevents the liquids from communicating freely, a difference of level is sometimes observed in the direction of the current.

It has been shown that all the higher salts of iron in traversing the system become converted into protosalts. A similar transformation ensues when iron trichloride is brought into contact with albumen. If in the other leg of the U-tube red prussiate of potash be placed, there will be observed, at the end of two or three days, a fine blue color at the part where the two liquids have come in contact. (4)

ELECTRICAL CONDUCTIVITY OF VARIOUS BODIES.

M. DU MONCEL found invariably that *black* silk gave very large galvanometer readings, while other colored silks scarcely gave any deflections; those that gave the least readings also, curiously enough, cost a higher figure. The conclusions deduced from the experiments are that, contrary to the generally accepted opinion, the silk stuffs reputed to be insulators are a long way from being so, and that during a period relatively dry woolen stuffs are more generally insulators than silk stuffs—at least for voltaic currents. Color does not seem to have any well-marked action upon wools. On inquiry into the manufacture of *black* silk, in order to discover the cause of its greater conductibility over other colors, it appears that manufacturers impregnate it with a large quantity of iron and tannin: hence the reason, liquids being much better conductors according as they contain saline materials in solution. And this process is precisely what takes place in the substance of the black silk, through its becoming impregnated with moisture on account of its hygrometric property. Linens most readily absorb atmospheric moisture, and give greater deflections the greater its coarseness. Cotton goods are likewise large conductors, but to a less degree; the coarser the texture, the better the conductivity. The galvanometer indications are so exact for these different sorts of "stuffs," that it is possible to detect the presence of either cotton or thread in silk or woolen materials. The effects of polarization are less than with minerals, and from carefully repeated experiments the following conditions were arrived at: For a certain direction of the battery current the effects of polarization gave place to an increase of that current, and for the contrary direction they determined a considerable and rapid fall. (4)

NOVEL FORM OF ELECTRO-MAGNET.—M. Deleuil found it desirable to substitute for the permanent magnet (used to extract iron particles from the paste or dough of unmanufactured porcelain) an electro-magnet, so arranged that the liquids contained in the paste into which the magnet has to be plunged should not penetrate into the coil. A magnet was devised as follows: A hollow coil was inclosed in a covering of sheet-iron, whose interior diameter was just large enough to allow the introduction of the coil. The iron parings and chippings contained in the paste are found to attach themselves to it in great abundance, and suit the purpose admirably.

DISTRIBUTION OF ELECTRIC CURRENTS,

F. GUTHRIE showed experiments illustrating the distribution of a current of electricity in passing from one pole to another across a conducting medium. This was shown in the case of solids by the stratification of iron filings in sheets of tin-foil and lead. A current of electricity was passed between two points in a horizontal line lying on the surface of a sheet of metal placed vertically in the magnetic meridian, and the distribution explored by means of a freely-suspended magnet needle. As the needle was gradually lowered, its direction of deflection was observed to change at a certain point from east to west. This point was ascertained by experiments to be at a distance below the horizontal line in which the current entered and left the plate, equal to one-third of the interval between the poles. A similar effect was shown in a liquid conductor.

NEW GALVANIC BATTERY.

J. A. FLEMING has invented a new battery, in which metallic contact of dissimilar metals is entirely avoided. The battery consists of thirty test-tubes of dilute nitric acid, alternating with the same number of tubes of sodium pentasulphide, all well insulated. Bent strips of lead and copper alternately connect the neighboring tubes. By this device the terminal poles are of the same metal. On connecting with a coarse galvanometer, the needle is violently and permanently deflected. Tested by the quadrant electrometer, the potential is found to increase regularly with the number of cells. The sixty cells, on first immersion, show an electro-motive force exceeding that of fifteen Daniell's cells. The principle upon which the action depends is, that in the acid, lead is positive to copper; in the sulphide it is negative. By using the single fluids, nitric acid and the single metal iron, a similar battery can be constructed, provided one-half of each iron strip is rendered passive. In this form also no metallic contacts occur.

NEW GALVANIC BATTERY.—The Eastern Railway Co (France) use the following battery: A series of superposed vessels of cast-iron, iron, zinc, lead, or other metal attacked by the exciting liquid, is arranged so that each vessel is attached to a carbon cylinder fixed externally beneath the vessel so as to dip into the vessel next below. The carbon cylinders are connected to the metal vessels by leaden collars, while the metal vessels are insulated from one another by a layer of mastic or an india-rubber washer, so arranged as to close the vessel hermetically. The exciting liquid used is a solution of ferric chloride.

AN EXPERIMENT IN MAGNETISM.

A MAGNETIC needle mounted on a disc of cork, if put in a basin of water, is far more free than when suspended by a thread. When a small horse-shoe magnet is laid in the bottom of the basin, with from one to three inches of water over it, the needle will sail around the poles, finally assuming a position across the horse-shoe at about one-third of its length.

With a bar magnet, its motions are different, but its perfect freedom to assume its proper position serves to show the lines and centres of force.

Another experiment is to put one of the magnets in the basin, with about one eighth of an inch of water over it; take a small file and a bit of iron, and let the filings drop on the water over the magnet. The filings sail into position from the outside and near the centre, and float down the middle of the magnet into the well-known curves.

ELECTRICAL COUNTRIES.

CERTAIN interesting phenomena have recently been noticed by the Hayden Expedition in the mountains of Colorado, showing the high electrical state of the elevated position known as Station 9, Uncompahgre Peak, during the passage of a storm. Although the indications of a change in the weather could be seen at a distance, the electricity at the point of observation did not become plentiful until a characteristic buzzing was heard. Painful sensations followed, and at the back of the head and at the elbows a sharp pricking, like that of needles or a sharp knife, was felt. By this time the party came to the conclusion that they were standing on dangerous ground. Those standing on the very summit of the peak and along the sharp ridges leading from it, experienced the severest shocks. After beating a hasty retreat, and remaining on the side of the mountain to continue observations, it was noticed that after each discharge or flash of lightning, a short rest ensued, until a sufficient quantity of electricity had again accumulated. Those nearest the point struck would feel a heavy shock pass through them. These same phenomena were noticed during three days of continuous storms. At many places the rocks were glazed where the electric current had passed. The formation of tubes in sand from the same cause is well known.

A French meteorologist, M. Fournet, has suggested that it would be an interesting question for Science to determine whether certain countries or regions are in a

higher electrical condition than others, and whether meteorological reactions do not result from the unequal distribution of electricity. Similar phenomena to those detailed above have been noted upon the elevated plateaus of Mexico, and nearly a century ago Volney recorded remarkable noises occurring during thunderstorms in the neighborhood of Philadelphia. In South America, at Popayan, province of Granada, Boussingault says that thunder is heard every day, and electrical phenomena are common. The extreme dryness of the Andine table lands also favors similar effects, and it is said that in the Chilian desert involuntary erection of the hair upon animals, as well as the appearance of sparks leaping from clouds to soil, is common. Dr. Livingstone notes that during the spring, a period of great dryness, the African deserts are traversed by a warm north wind so highly charged with electricity that the plumes of the ostrich stand upright, and that sparks are produced by the mere attrition of the garments.

In India, at certain localities, telegraphic wires are maintained with great trouble. It is stated that during storms of exceeding violence the conductors become charged almost to melting. Professor Loomis has observed abundant electricity in the atmosphere about New York city, especially during winter. We have repeatedly remarked the high electrical condition of the hair on cold nights, and also that the mere act of walking on a soft carpet in a heated room will cause a cracking sound under the foot.

From all the various examples which have been collected of this curious condition, it would appear that the abundant presence of electricity is not due necessarily to heat of the season, since in this country it is never more strongly manifested than after a cold northwest wind; nor are indications in any other region more clear than in the dry and icy air of Siberia. It would appear that the reservoirs of electricity exist in the most widely separated parts of the globe. If it be admitted, in accordance with the opinions of Fournet, Maury and Admiral Fitzroy, that the ordinary winds are in relation with these great electrical sources, further and more extended operations upon them would be in the interest of meterological progress. If, for example, the electricity of each great atmospheric current, tropical or polar, is regularly positive or negative, it may be, as Fitzroy suggests, believed that the changes of weather which supervene, at the moment when one electrical current succeeds the other, have on a small scale a certain analogy to the changing of the trade

winds. Fournet remarks upon a natural relation of these phenomena with the meteorites produced during storms. These views are, however, mainly conjectural, so that there remains a large field for definite research.

ON SOME PHENOMENA OF ELECTRIC INDUCTION.

A SHORT time since it was proved experimentally by an Italian physicist, Professor Emilio Villari, that an electric current takes a longer time to reach its full intensity in a circuit of iron than in one of copper, having the same form and the same resistance. Supposing it probable that the phenomena of induction also would not be independent of the nature of the primary circuit, he has recently made a series of measurements with two induction coils of the same form and size, the one of iron, the other of copper; the resistance of the two conductors being first made precisely equal, in order to which he inserted a brass wire in the circuit. The induction was measured by the magnetism produced by the secondary coils. Prof. Villari gives the following as the results of his variously modified experiments:

1. Iron offers to the interrupted electric current, and still more to the reversed, a greater resistance than to the continuous current.

2. The duration of the variable state of the current in iron is greater than in copper, and especially if it is flowed through by currents with opposite directions.

3. In consequence of this increase of duration of the variable state, the induction current of a current flowing through iron is, under like conditions, of less tension than that induced by a current flowing through copper.

4. The tension of the current which is induced by copper in iron is less than that of the current induced by copper in copper. These phenomena relate to the current induced on closing, and are more pronounced if the primary current is each time reversed.

5. The action of the iron increases with the length of the wires; it increases with the intensity of the current up to a certain limit, which approximately coincides with the maximum of magnetism of the iron, and is nearly independent of the thickness of the wires.

6. The tension of the opening current is greater between circuits consisting entirely of copper than between circuits that consist partly of iron.

7. All these facts arise from the production of transversal magnetism in the iron by the current passing through it, whereby the establishment of the electric current which enters it is delayed.

PLATINUM ELECTRODES.

D. MACALUSO states that a platinum plate, immersed in pure hydrochloric acid, was opposed to a similar plate immersed in hydrochloric acid containing free chlorine; it was found that the electro-motive force of the latter gradually increased till a certain point was attained, and the further addition of free chlorine caused the electro-motive force to increase until it became equal to about 0.62 of a Daniell's element. This gradual increase renders it probable that the polarization is due to the adherence of chlorine to the plates, and is independent of the amount of free chlorine in the solution. Chlorine which is electrolytically evolved on the surface of a plate appears to be more active than ordinary chlorine.

Platinum electrodes appear to absorb or store up a considerable proportion of active chlorine, which gradually changes to the ordinary modification when the polarizing current is broken.

CLOCK-TIME BY TELEGRAPH.

THE method introduced by Prof. Joseph Winlock, Director of Harvard College Observatory, by which the time is communicated to the city of Cambridge, to the city of Boston, to all the railroads centering in Boston, to many jewelers and private establishments, and the watch factory at Waltham, is as follows: The method consists simply in inserting into the circuit passing through the clock an ordinary telegraphic sounder. At every second beat of the pendulum the circuit is broken and a click of the magnet is heard. By a simple device, the clock is made to omit every fifty-eighth second. When one, therefore, wishes to ascertain the error of his time-piece, he has only to watch for the omitted break, and the first click thereafter is the exact beginning of a minute as shown by the time-clock at the Observatory. At every even five minutes there is an omission of about 25 seconds preceding.

The time-clock is kept correct by adding to or removing from the pendulum, shot of various sizes. A single bird-shot of average size produces an effect of about one-tenth of a second per day upon the rate, but this correction often requires the exercise of considerable judgment, as it frequently happens that while the addition of one, two, and sometimes even three shot produce no apparent effect, the addition of a fourth produces the effect due to all the shot added. This method possesses this decided advantage, that it can never give the time incorrectly. In the system of controlled clocks, if the current fails, the clock

may meanwhile gain or lose, and when the current is restored the error of the clock remains; but in this method, under similar circumstances, one must do what is necessary to be done when one wishes to send a message over a broken line—wait till it is repaired. When the circuit is restored, the same instant the time is correctly given.

(144)

ACTION OF THE ELECTRIC CURRENT ON THE ORGANS OF THE SENSES.—It results from experiments made by T. L. Phipson that the action of a galvanic current on the organs of sensation always appears at the positive pole, except at the moment where the negative pole becomes in turn positive, and then an action takes place at this pole. He thinks that in these facts is found the indication of a general law applying equally to the muscular contractions occasioned by electricity, and very probably to the phenomena of induction. If we take a small zinc-copper couple, plunged in acidulated water, and furnished with a platinum rheophore, and place first the zinc pole on one side of the tongue, and then the copper pole on the other side, the well known and peculiar taste is immediately experienced at the point touched by the copper, but not on the other side. The result is the same if the positions of the poles are changed. If a stronger apparatus is used the phenomena are unaltered; but another fact is also observed—on removing the copper pole, the same taste is experienced at the zinc pole. Corresponding phenomena are observed in experimenting on the organs of hearing, smell, and sight.

MAGNETIC METALS.—W. F. Barrett gives the following numerical relationships between certain of the physical properties of the closely allied magnetic metals, iron, cobalt and nickel.

	Iron.	Nickel.	Cobalt.
Specific gravity	7.8	8.3	8.5
Atomic weight	56.0	58.5	58.5
Specific heat	0.1138	0.1091	0.1070
Atomic heat	6.38	6.38	6.26
Dilatation by heat	0.0926	0.0899	0.0981
Dilatation by strain	0.0387	0.0394	0.0456
Conductivty for heat	0.168	0.131	0.172
Conductivity for sound	5.3	14.9	14.2

In numerous chemical properties these three metals are closely allied.

CHROMIC ACID SOLUTION FOR BATTERIES.—An improved recipe by which a stronger current is produced is as follows: Twelve parts by weight potassium bichromate in 150 parts of water, with addition of 25 parts of sulphuric hydrate.

BRITISH CONSTRUCTION OF TELEGRAPHIC APPARATUS.

R. S. CULLEY states that small insulators, formed of good porcelain, are the best, although, on several accounts, ebonite is recommended. Dirt and moisture are the principal things to be guarded against, but not all; for many mischievous boys, who would not take the trouble to break an unpretending black cap, can not resist the temptation of throwing at a large white one. Insects, especially spiders, are a source of peculiar annoyance. In the high roads of Ireland they are very troublesome, and in India, however large an insulator may be, an insect of the proper size is always ready to inhabit it.

With respect to the construction of a line of telegraph, the author states that it is preferable to use suspended rather than buried wires, because of the liability of gutta-percha and india-rubber to deteriorate underground, the expense of repairing faults, and the retardation of signals in consequence of the greater inductive capacity of wires so laid. On the other hand, gutta-percha is indestructible in sea-water, which is not, however, the case with india-rubber.

Great care must be taken in the selection and preparation of poles for supporting the wires, and extra precautions against accidents must be taken in various cases. The number and position of the poles depend very much upon the force and direction of the winds, and minute instructions are furnished on these and numerous other points.

The wire itself must be soft, and capable of stretching eighteen to twenty per cent before breaking. Great attention is now directed to the manufacture of telegraph wire, which is drawn to lengths of 80 or even 120 ft. The wire must be galvanized, no system of painting or varnishing having been found to answer so well; although, in some situations, where exposed to the action of the corrosive gases of the atmosphere of great towns and manufacturing districts, or to sea spray, painting, or even coating with gas-tar, in addition, is necessary. A peculiar rattle indicates to educated ears when a wire has parted; but repairing or jointing is a delicate operation, requiring also great attention to cleanliness on the part of the workman. Testing is another operation requiring great care and skill of another kind.

In the instruments used for signaling there is often a wonderful display of ingenuity, and it is interesting to trace the path of invention in this respect. With the sim-

ple needle instrument all are familiar. The "sounder," an adaptation of the bell-instrument, is, with very insignificant exceptions, the only telegraph used in the United States, and its use is daily extending in England. The signals are the dash and dot of the Morse alphabet; in fact, the signals of the Morse apparatus itself can be read by the sound of the armature. The sounder, although slower than the bell-instrument, requires less skill in the operator; its signals can be read as fast if not faster than they can be transcribed, and it is less liable to disturbance; it will, in fact, work well where the bell fails. The great advantage of the bell and sounder over the needle is, that the clerk writes, as it were, from the dictation of his instrument, and confused signals are more readily deciphered by the ear than by the eye, just as indistinct speaking is more readily understood than indistinct writing.

Recording telegraphs write their own signals on paper, the characters being the dashes and dots of the Morse alphabet. According to the Bain, system the signals are produced by chemical decomposition. In the Morse recorder a point or style attached to the armature of a magnet embosses a mark upon a revolving band of paper on the breaking of the current. An improvement in the recorder is Disney's ink-writer, by which a pen in the same position as the style writes the sign on the paper band, with a species of printer's ink.

The latest improvements in signaling are in the direction of automatic instruments, by which a much higher speed can be attained, and with more accuracy, than by hand; and by them may be transmitted even a fac-simile of handwriting. The duplex system, by which it is possible to signal independently from both ends of the circuit at the same time, thus doubling the working capacity of a wire, is successfully progressing.

PHOSPHORESCENCE IN GLASS.

By Prof. A. W. Wright.—In certain forms of Geissler tubes the platinum wires are inserted so far as to leave an interval of only one-sixteenth of an inch between their inner ends, and the rarefaction of the air is carried to such a point that no spark can be made to pass across even this small interval. When the extremities of such a tube are brought in connection with the poles of a powerful electrical machine or induction coil, the glass, under the influence of the electricity, becomes excited in such a way as to produce a luminous ring of a vivid green color, encircling the tube, and situated a short distance from the interval between the wires, toward the negative end of

the tube. After the discharge has ceased, the glass remains luminous for a considerable time. When this light is examined with a spectroscope it is found to give a continuous spectrum, most intense in the green, but extending, with an intense charge, over the whole extent of the usual solar spectrum. With feeble electrical charges it forms a broad band in the green, at the point of greatest intensity observed in the other cases.

Experiments with various kinds of glass exposed to the action of intense sunlight in a Becquerel's phosphoroscope, gave light of a similar color, the spectrum of which, in the case of some kinds of glass, was of the same nature as that produced by electricity. Although the tube itself did not transmit the discharge in the ordinary way, the glass appeared to be put into a condition of intense electrostatic polarization, the result of which was a slow equalization of the opposite electrical potentials near the centre of the tube. The glass was thus subjected to a molecular action sufficiently energetic to render it vividly luminous.

When the discharge was made very powerful by means of condensers, the brilliancy of the light was greatly increased, and the tube appeared as if red-hot, or even white-hot. When a magnet was brought near the luminous ring, the latter was tilted upon its axis, in the direction of the Ampérian currents.

ABSORPTION AND REFRACTION OF LIGHT.

BODIES may be viewed, says C. Pusch, as possessing three distinct but partially correlated powers, namely, in reference to their absorption, refraction, and reflection of light. In transparent bodies the light may be supposed to be propagated by the component atoms themselves, as well as through the ether surrounding them, that propagated in the former way being retarded: if the component atoms have a high reflective power, much light must be taken up by successive reflections inside the body, *i. e.*, absorption takes place. A ray which is readily absorbed is therefore easily retarded and easily refracted anomalously, and likewise easily reflected, a point proven by Stokes and by Kundt. An exceptional power of refraction is therefore connected with exceptional powers of absorption and reflection. Gases which absorb some kinds of light with great activity, must therefore reflect these kinds of light just as powerfully; wherefore a free gaseous mass of this kind must show by reflection (like certain solids and liquids) a spectrum marked with bright lines in the places where the dark lines occur in the absorption spectrum. An application of this principle to cometary light is thus suggested.

A NEW SPECTROSCOPE.

THE instrument is the invention of Prof. A. K. Eaton, of Brooklyn, N. Y., and is by himself named a direct-vision spectroscope. It consists of a thick plate of glass with parallel sides, united to one of the faces of an ordinary bisulphide of carbon prism, or a prism of dense flint-glass. According to the amount of dispersion desired, the light is made to enter either on the end of the glass plate, or on the opposite face of the bisulphide prism. The results obtained from this instrument are as follows: The dispersion of this compound prism is nearly four times greater than that of the ordinary 60° prism. The mean emergent ray is practically parallel to the incident ray. It does not deflect the way from its original path. Many Frauenhofer lines are visible by this prism with the naked eye, while with the observing telescope all the prominent lines are clearly reversed, without the use of the slit or collimeter, by merely throwing a strong beam of light by means of a mirror.

When the usual appliances of slit-collimeter and telescope are employed, it widely resolves the D-line and shows the nickel line between these two lines—a result claimed as the best obtained by a four-prism instrument of Browning.

It is stated that a simple bisulphide prism in this instrument gives a dispersion of 40° between the B and G lines; when it is used for projection it gives a spectrum 8 feet long at a distance of 10 feet from the screen, enabling 100 dark lines to be counted.

It is evident, therefore, that this prism promises to become a most valuable instrument for projection in the lecture-room, while either solar, electric, or oxyhydrogen illumination may be employed, having the great advantage of simplicity of adjustment, since it avoids the necessity of turning the lantern after the slit has been focussed on the screen.

ELECTRICAL GAS LIGHTING.

THE gas burners in the Hall of the National Assembly at Versailles are lighted by electricity. A Ruhmkorff coil of medium size, with an automatic mercurial interrupter, is set in action by a Leclanché battery of four elements, the zincs having a surface of 4 square decimetres. These are only equivalent to three Bunsen elements of a middle size, bnt their duration is much greater. Under the influence of this battery the coil gives sparks of 15 centimetres. To transmit the electricity to the different lustres a special wire is employed for each, but the return current passes through one common wire.

HAMILTON'S NEW MUSICAL DISCOVERIES.

MR. JAMES BAILLIE HAMILTON, of University College, Oxford, has made a communication to the Physical Society, London, on his new discovery relating to the application of wind to stringed instruments. Mr. Hamilton commenced with a short history of the efforts which had been made to bring the Æolian harp under human control, and explained how he himself had taken up the matter from Mr. John Farmer on leaving Harrow School. Mr. Farmer had suceeeded in getting wind to do the work of a bow upon a string by attaching a reed to the end of it, forming thus a compound string from which a few notes of great beauty could be obtained. Mr. Hamilton, in attempting to complete a perfect instrument, soon found he had undertaken an almost impossible task, from difficulties which he explained to the Society. Failing to obtain advice or assistance, either from scientific men or from the musical instrument makers, he was once more thrown upon his own resources, and, conscious both of his responsibility and difficulties, resolved to leave for a time his university career, and to investigate to the uttermost a matter on which no information could be there obtained. The results of his investigations were then shown to the Society. After two years of labor, Mr. Hamilton had not only gained experience sufficient to perform what he had undertaken, but had also discovered that by a different mode of employing the same material, *i.e.*, a string and a reed, he could secure for a string the advantages it afforded by an organ-pipe in addition to those which it already possessed. Showing a pianoforte string on a sound-board, he said: "Such strings already possess certain advantages; first, simplicity of reinforcement by a common sound-board; second, economy of space; third, blending of tone; and, fourth, sympathy. Can I also secure for this string the advantages of an organ-pipe—namely, first, special reinforcement; second, volume of tone; third, choice of quality; and, fourth, sustained sound?" Accordingly, an open diapason pipe was proposed for imitation, and, to the general surprise, the string was made to exactly imitate it in all these respects. Another string was next sounded, representing the note of the largest organ-pipe in use, in conjunction with other notes, satisfying the hearers that not only could a string do all the work of an organ-pipe in giving volume and sweetness to the note reinforced, but could afford the exquisite sympathetic and blending power hitherto peculiar to strings. Such notes were also sounded seven octaves apart. The reinforcement corre-

sponding to the pipe was secured by the utilization of a node which cut off from the string a segment corresponding to the note reinforced, presenting to all appearance the phenomenon of an organ built by nature out of a string. This node being a source of motion, is also utilized for gaining quickness of speech, since a cord, acting as a damper, and stretched across the nodal line of a series of strings, serves to communicate instantaneous sound from key to key. Another invention of Mr. Hamilton's was a string which could not be put out of tune, to the great surprise of those who attempted to do so. He also exhibited a new pianoforte string, which by its purity and volume of tone showed that the results of a grand pianoforte could be obtained in a cottage instrument. Mr. Hamilton having satisfactorily answered several questions respecting possible objections, concluded by reminding the Society that it was in attempting faithfully to carry out the designs of another man that he was now in a position not only to perform what he had undertaken, but had also been permitted to bring into use a simpler, purer, and grander source of sound than had been contemplated when he laid his hand to a task which he was still engaged in perfecting.

VIBRATIONS OF ORGAN-PIPES.

THE mechanical theory of sound from organ-pipes assumes expansions and contractions — rarefactions and condensations—of the air inclosed. The methods of testing the changes of density consist of apparatus in which the vibrations are communicated to flames. Professor Joseph Lovering has devised a new instrument for this purpose. Imagine eight arms of gas pipe, each one foot in length, arranged as the spokes of a horizontal wheel upon a hollow hub, which is lengthened out below to the extent of six inches. This hub is closed at the top by steel and is balanced upon a steel point at the top of a hollow upright, through which the gas is delivered. Two holes are made in the sides near the top, through which the gas flows out into the hollow hub and the attached arms. The upright comes up through the bottom of a vessel, into which water is poured in sufficient quantity to immerse the bottom of the hub and prevent leakages of gas below. In this way great freedom of motion is secured on the steel point with a perfectly tight joint. The arms are rotated in a large circle by clock-work, and their weight suffices to make them serve as a fly-wheel and produce a uniform motion. The arms are closed at the ends and the gas issues in eight vertical streams from as many holes in the tops of the arms. When these streams

are lighted, the rotation produces a large cylindrical sheet of light. The larger the number of arms, the smaller the velocity required to produce persistency of impression in the eye, with the additional benefit of having a well-balanced instrument. Vibration of the flames is produced by attachment to the organ-pipes similar to Koenig's. When the full pressure of the gas is on, the cylindrical sheet of light is three or four inches in height, and when the organ-pipe speaks it is broken up as neatly as when the vertical image is used in Koenig's apparatus. The effect can be seen readily in full daylight and from every part of a large room. The best effect is with organ-pipes at least three feet in length and open at both ends. Of course, the serration is finer when longer pipes are used. The effect is very beautiful, even with short pipes, if the flame is brought down to the size of a pea: in this case the illuminated circle, as soon as the sound begins, is broken up into bright beads loosely strung upon a dark cord.

WIND-RECORDING INSTRUMENT.

THE apparatus for velocity consists of a movement for giving motion to a set of type-wheels, which is unlocked for each tenth of a mile of wind. Four brass type arms, on which are engraved the letters N. S. E. W., are placed on the prolongation of the shaft, carrying the type-wheels for velocity; and these arms, by means of connecting rods, are attached to the armatures of four electro-magnets. Telegraph wires communicating with the vane shaft and magnets cause one or more of the letters to be elevated for printing whenever the battery currrent is completed.

By means of a half second pendulum clock, an impression for direction and velocity is made hourly on a slip of paper two inches wide and eight inches in length, as follows:

Time.	Direction.	Velocity.
0	N. E.	342
1	N.	360
2	N. E.	372
3	N. E.	385

The first column is the time, the second direction, and the third velocity in miles.

This is the first and only mechanism for *printing* the direction and velocity. The total distance traveled by the wind in a day, month, or year, is read from the sheet without computation; consequently, the device is eminently labor-saving.

THE sodium flame may be rendered absolutely monochromatic by causing the light from the flame to pass through a split plate of potassium dichromate.

THE CLAMOND THERMO-ELECTRIC BATTERY.

In 1821 Professor Seebeck, of Berlin, discovered that by soldering together a bar of bismuth and a bar of copper, and applying heat to the junction, an electric current was generated of sufficient intensity to be plainly indicated by the galvanometer needle. To this current and couple, he gave the name of thermo-electric, in order to distinguish them from the hydro-electric or ordinary current and couple. The thermo-electric current is ascribed by Becquerel to the unequal propagation of heat in the different parts of the circuit, since, when all the portions of the latter are homogeneous, no current is produced on

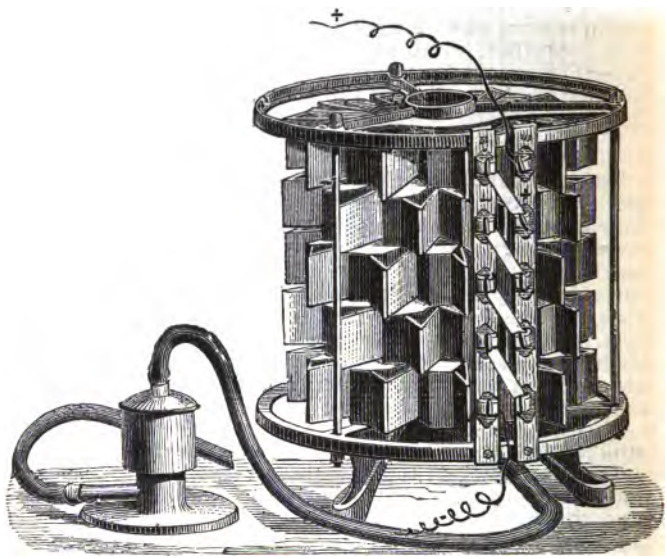


FIG. 1.—THE CLAMOND THERMO-ELECTRIC BATTERY.

heating, because the heat is equally propagated in all directions. As compared with the hydro-electric current, the electro-motive force is very small, producing but feeble chemical action.

It is unnecessary to enter into the details of past investigation into this subject, since a reference to any standard work on physics will afford all necessary information.

The principal application of thermo-electricity is to be found in the thermo-electric battery, which accumulates

the tensions produced in a circuit composed of several metals, when the alternate solderings are heated, the others being kept at constant temperature. This battery, in the form of Nobili's pile, employed in connection with a galvanometer, is used in Melloni's thermo-multiplier for measuring temperature, the slightest differences in which it indicates with unfailing accuracy.

Save for purposes of demonstration, the thermo-electric pile has been of little practical value. It has played no part in industrial operations, though attempts thus to

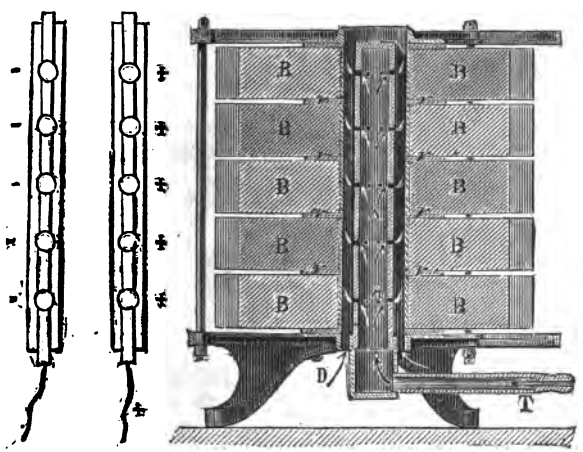


FIG. 2.—CROSS-SECTION OF THE CLAMOND BATTERY.

utilize the current have not been wanting. Farmer exhibited two models at the French Exposition of 1867, of ingenious construction, but they lost their power rapidly, and the bars, being excessively fragile, broke in cooling. In 1869, Becquerel presented to the French Academy a battery constructed by MM. Clamond and Mure, of couples of galena and iron plates, in which, however, the current gradually weakened because of the augmentation in the resistance of the apparatus. As this invention formed the basis on which the remarkable device which we are about to describe is founded, it may be well to notice more carefully its defects and the means taken to cure them. The difficulties lay, first, in the oxidation of the contact of the polar plates with the crystallized bar under the influence of heat. Second, in the splitting of the bar of galena and its separation into different portions in planes perpendicular to its length.

The result of M. Clamond's efforts to overcome that was the battery represented in our engraving—in perspective, Fig. 1, section, Fig. 2, and plan, Fig. 3. In order to get rid of the first trouble, he altered the mode of attachment of the iron plate, bending it back on itself irregularly, so as to present many re-entering angles. These are made to envelop the bar, so that as the latter heated, it expanded more than the surrounding metal, and so forced itself all the tighter into the angles. This disposition will be understood from Fig. 3, in which B B are the bars, and L L the plates. The second difficulty offered greater obstacles, as it had been found that when a thermo-electric body, either metal or metallic sulphide, is cast in a cold cubical mold, splitting ensues, parallel to the faces of the cube. These divisions become visible after heating, and are supposed to be due to the extreme fragility of the body and its crystallization against the surfaces of the mold. In order to prevent splitting, M. Clamond heated his molds to temperatures nearly equal to the fusing-point of the thermo-electric substance, and employed couples made of an alloy of zinc and antimony (in lieu of galena), and his iron plate as before. This alloy he adopted on account of its good electrical conductivity, and because the temperature of its melting-point rendered his method of casting easier. Iron he used in preference to copper or argentar, because it resists the effects of the alloy more effectually.

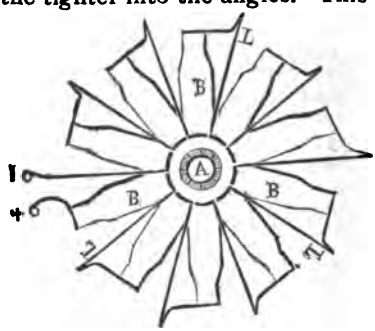


FIG. 3.—PLAN OF THE CLAMOND BATTERY.

The bars of alloy, as shown in our engravings, are assembled in crowns and coupled for tension. These crowns are each composed of ten bars, B, Fig. 2, superposed and separated by collars of asbestos. The apparatus forms a cylinder, the interior of which is lined with asbestos and heated by means of a pipe, A, of refracting clay, pierced with holes. The gas entering at T escapes through these orifices, and mingling with air, which comes in at D, burns in the annular space between the tube and bars. The extremities of each crown are held in clamps of copper fixed in two standards, shown separately at the

left of Fig. 2, and at the front of the apparatus in Fig. 1. The crowns may be coupled for tension or for surface, the latter for each crown being 7 square feet, or 35 square feet for the entire battery.

The Gerond regulator is used to render the flow of gas uniform; and, thus arranged, the battery works for months without requiring the slightest attention. The apparatus exhibited before the French Academy of Sciences uses one cent's worth of gas per hour to deposit 308 grains of copper in similar time. So that for fifty cents 2.2 pounds of the metal may be deposited. The quantity of electricity augments in proportion to the size of the bars, which are made of different dimensions, varying from half an ounce to nine pounds. Experiment also shows that, with an equal number of couples, the weights of copper deposited are proportional to the weight of the couples.

The battery, we understand, is now being used in the printing-office of the Bank of France, and in the large photo-engraving establishment of Goupil, at Asniéres, giving remarkably successful results. (121)

TRANSMISSION OF SOUND.

By Prof. Joseph Henry.—Attempts have been made to penetrate fog by light; but even the light of the sun itself can not penetrate a mile of fog, much less any artificial light. The only method known of communicating signals is by sound. Bells weighing 2,500 pounds and great guns have been tried with little success. The whistle, the reed trumpet and the syren are far more efficient, especially the latter. The syren was then briefly described. The pitch has much to do with penetrating to a distance; not the highest nor yet the lowest pitch has great penetrating power. In the case of light, its transmission can be increased by placing it in the reflecting focus of a parabolic reflector. The same is the case with sounds on a small scale. But with great sounds—traveling distances of from three to five miles—you can hear as well behind the parabola as in front of it.

Professor Henry does not exactly accept the deductions recently made by Professor Tyndall, having himself observed a large number of similar phenomena, and attributing them to refraction, not absorption, of sound by wind and other causes. Professor Henry found Tyndall's explanation that a mixed atmosphere absorbed sound, inadequate to explain the facts. The practical interference, and therefore the practical absorption, must be very inconsiderable compared with the volume of sound. In the case of the syren, such is the intensity of the sound that it would cause sand to dance on a stretched membrane at

a distance of one and a half miles, while a 2,500-pound bell would not set the same sand in motion at a distance of 30 yards.

With a wind directly against the sound, an instrument that could be heard 25 miles away is reduced in penetrating power to two miles. Mr. Stokes first gave a hint of the true explanation of this fact in respect to the deflection of sound by winds. The great and notable effect that even a feeble wind produces on sound, is in changing the direction of the waves so that the sound is carried upward. This process was illustrated by a very simple diagram on the blackboard. The retarding of the waves at successive heights by wind, and the new direction that would thus be acquired by the waves, was very clearly shown, and the illustration elicited a round of applause.

It has been frequently observed that a distinct echo is sometimes obtained from the ocean. Professor Tyndall thinks the reflection is from surfaces of wind. Professor Henry thinks it is from the surface of the waves of the ocean, and that the sound is afterward refracted by the wind. (144)

RECENT ADVANCES IN SCIENCE.

In 1870 Prof. Guthrie gave an account of the attraction of a light body by the vibration of a tuning-fork. Thomson, repeating the experiment, attracted a suspended eggshell by a wave of the hand. The experiments were considered as throwing new light on the doctrine of attraction. Prof. Challis, in an elaborate work, has discussed the interplay between ether and atoms, and the theory may now be regarded no longer as a speculation, but as a physical reality, with substantial mathematical supports. He does not yet claim full mathematical proof, but his work is a guide-post that unmistakably points the way. In one respect the theories of Le Sage and Challis coincide; the driving storm of atoms must come from outside the world of stars; the universe is not even temporarily automatic, but must be fed continuously by an agency external to itself. Our science thus is not a finality.

The law of conservation of energy, the child of the correlation of physical forces, was then considered in brief historical review, and it was claimed that Newton, Leibnitz, Huyghens, and Bernouilli had laid some foundation for this discovery. The caution with which Lagrange presented similar mechanical principles was referred to. Physical science can only assert that it possesses no evidence of the destruction of matter or force. The conception of matter as moving atoms was as old as Lucretius. The ring-vortex theory of Helmholtz in 1858 was a most

important addition to the philosophy of the atomic conception. The element of the new physics is not an atom or a congeries of atoms, but a whirling vapor. The music of the spheres has left the heavens and descended to the molecules.

We have no conception of inert matter or disembodied force. All we know of matter is its pressure and its motion. If it could be shown that all the phenomena displayed in the physical world were simply transmutations of the original energy existing in the molecules, physical science would be satisfied.

The great problem of the day is how to subject all physical phenomena to dynamical laws. The obstacles are innumerable, but we shall not rest till they are overcome. We applaud with good reason the brilliant results of experimental research, but mathematical analysis with its multitudinous applications is the only key which will fit the intricate wards in the treasury of science. Through her mathematicians, England holds to-day a position in science that she has not held before since the days of Newton. In Germany the physicists do not hesitate to grapple with the most intricate problems. In France the scientific spirit is aroused to a degree unknown since that which preceded her first revolution. Her Association for the Advancement of Science has sprung almost at birth into full-grown power. The words of its first President are as true for the United States as for France: "The strength and glory of a country are not in its arms, but in its science."—*Prof. Lovering's Address.*

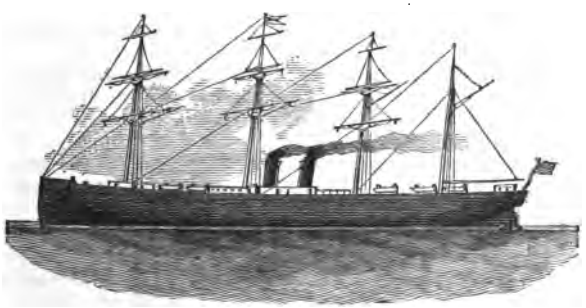
A SIMPLE LEVELING INSTRUMENT.

M. GOULIER proposes a pendulum hung by a double point, which carries, rigidly attached, a collimator formed of a small tube hermetically closed at one extremity by a piece of ground glass. At the other end is a converging lens, 18 inches in diameter and 54-inch focus. The radius of the exterior face of the lens should be six or seven times less than that of the interior face. At the principal focus is a diaphragm pierced with a hole 0.06 inch in diameter, across which is a thread of black cotton. By suitable construction, the pendulum being at rest, the plane passing through the thread and the optical centre of the lens is horizontal. On looking through the lens, the observer sees the thread as a horizontal line, which marks on the field the intersection of horizontal plane through the instrument. By placing the eye in proper position, the thread and exterior objects may be seen at the same time, and the mark on a leveling rod may be adjusted to coincide with the thread, so obtaining a level.

JOHN ROACH.

(See Biography.)

MECHANICS AND ENGINEERING.



THE NEW PACIFIC MAIL STEAMER "CITY OF PEKING."

THE revival of ship-building in this country, and the application of home-made iron for the purpose, were prominent incidents in the marine engineering of 1874. The banks of the Delaware River have become the headquarters of iron ship-building in America. A considerable number of vessels, of the smaller classes, have already been launched, and many others are in progress. Among the larger vessels are several steamers for the Pacific Mail Steamship Company. Two splendid ships for this company were finished during 1874, both of the same size and style, of one of which, the "City of Peking," we give above a miniature view. Both were produced by the same builder, John Roach, whose success has won for him the highest enconiums. We give herewith a description of the "Peking." The other vessel, the "Tokio," is of similar dimensions.

These vessels were designed to meet the requirements of a law passed in 1872, granting the company a subsidy for carrying the United States mails between the United States and China, but stipulating that they should be carried in American built iron vessels of more than five thousand tons burden. The following are the principal dimensions of the ship:

Length over all, 423 feet; length on water line, 407 feet; beam, 48 feet 9 inches; depth of hold, 38 feet 6 inches; tonnage (registered), 5,080 tons; draft of water when loaded forward, 22 feet, aft 24 feet; displacement when loaded

deep, 7,600 tons; midship section, 930 square feet; total weight of iron used in construction of ship, 2,400 tons; thickness of iron in skin of ship, $\frac{11}{16}$ to 1 inch; tons of space occupied by machinery, 1,120.

There are six water-tight compartments. Three of the four masts are of iron, and the after or jigger mast is of wood. The total area of canvass that can be spread is 2,400 yards.

The ship is propelled by two pairs of compound engines, each pair having two cylinders. Diameter of high-pressure cylinders, 51 inches; diameter of low-pressure cylinders, 88 inches; stroke of pistons, 4 feet 6 inches. The object of using two pairs of engines is to guard against having the ship disabled if one engine should break down. As the ship has to make a trip of more than five thousand miles, through an ocean which is almost always in a perpetual calm, the breakage of one pair of engines might necessitate her to make her way, under sail alone, twenty-five hundred miles, to the nearest point. But now, if any accident (with the single exception of breaking the crank-shaft, or the after engine, or the line-shaft or screw) happens, the remaining engine will suffice to bring the ship into port at a very slightly reduced speed. In order to avoid as far as possible the liability of breaking the crank-shaft, it has been made in excess of strength, the diameter being 18 inches (in place of $17\frac{1}{2}$ inches, as it would usually have been made), giving an excess of strength of 8 per cent over the usual practice.

The object in using a pair of cylinders in place of a single one was to divide the maximum strain upon the machinery into two portions, which are successively applied as each engine passes the centre, thus allowing the machine to be built lighter, and still to retain the advantage of a high boiler pressure and great expansion, and to obtain as good or better economy than can be had in a single cylinder.

The general style of the engines is of the type developed by the late John Elder, of Glasgow, Scotland, having two cylinders connected to cranks at right angles, and an intermediate reservoir called a receiver. The steam enters the high-pressure cylinders and follows the piston through about one-fourth of the stroke at a pressure of about 50 lbs., the difference between this and the boiler pressure of 60 lbs. having been lost in the friction of the steam-pipe and the intricate passages in the valves. The steam is expanded in the high pressure down to 8 lbs. above the atmosphere, and is exhausted into the receiver at a pressure of 5 lbs. above the atmosphere. From the receiver it is admitted into the low-pressure cylinder during nearly

one-third of the stroke, and is still further expanded to 7 lbs. below the atmosphere, or an absolute pressure of nearly 7½ lbs., where it is exhausted into the condenser, giving a total measure of expansion of nearly 9 times. In order to obtain this in a single cylinder, the steam would have to be cut off at less than one-twelfth of the stroke, and the variation of pressure would be from 68 lbs. to 6½ lbs. per square inch, in place of from 50 to 5 in the one cylinder, and from 15 to 5 in the other, as is now the case.

The steam to work these engines is furnished by 10 cylindrical boilers, having each 3 internal cylindrical furnaces. The products of combustion return through tubes above the furnace, each furnace having its own nest of tubes, separated from the others by water-legs. The steam passes through two superheaters on its way to the engine, where it is freed from the water held in mechanical suspension, and slightly superheated. The boilers are arranged in two sets, each set having its own superheater and smoke-stack, coal bunker, feed-pipes, and all fittings complete, as if placed in separate ships. The following are the principal dimensions of the boilers: Diameter, 13 feet; length, 10 feet 6 inches; diameter of furnaces, 3 feet 2 inches; length of grate bar, 5 feet 6 inches; diameter of tubes, 3 to 3¼ inches; length of tubes, 7 feet 6 inches; thickness of shell, 1⅛ inch; thickness of furnace, ½ inch; diameter of smoke-stack, 8 feet 6 inches; height of smoke-stack, 70 feet; total grate surface, 520 square feet; total heating surface, 16,500 square feet; total superheating surface, 1,600 square feet.

THE FASTEST STEAMER IN THE WORLD.

SUCH is the title claimed by Messrs. Thornycroft for a boat they have just built to the order of the Government of India, for service in the Orissa canals. The dimensions of this vessel are: Length, 87 feet; beam, 12 feet; draft of water, 3 feet 9 inches. The speed contracted for was 20 statute miles per hour. The hull, the working parts of the engines, and the propeller—Thornycroft's patent—are of Bessemer steel, and the woodwork is of teak. The official trial of the boat was made on the 14th ultimo under the inspection of Colonel Haig, R. E., chief engineer of the Bengal Irrigation Works, and the results were: With tide, 25.08 miles per hour; against tide, 24.15 miles per hour; giving a mean speed of 24.61 miles per hour. In another official trial it was shown that the boat could keep up a speed of 22 miles per hour without losing steam. These speeds are extraordinary enough in themselves, but when it is considered that they are attained by a boat only

87 feet long, they become absolutely wonderful. The value of swift steam launches as torpedo boats is acknowledged, and already various foreign governments have ordered boats from Messrs. Thornycroft's yard, near London. If torpedo launches can be built to steam at the rate of 16 or 18 miles an hour in a moderately calm sea, the whole face of naval warfare may find itself changed in a very unexpected way.

THE POLYSPHENIC SHIP.

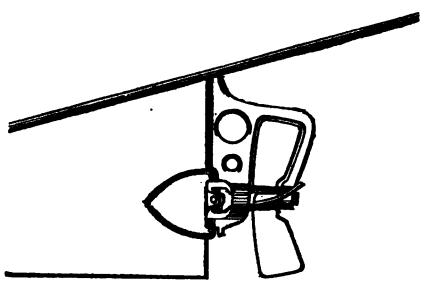
PROCEEDING from the well-known fact that when flat-bottomed vessels are urged forward by a strong propelling force their bows are lifted, and in that way some advantage of speed is gained, Mr. Charles Meade Ramus, M. A., Trinity College, Cambridge, designed a ship in which the bottom was composed of two parallel and consecutive inclined planes, so that, being simultaneously lifted fore and aft by two similar lifting forces at the highest rate of speed, it might be able to so maintain its equilibrium as neither to drop forward nor turn over. Experiments with models showed that a vessel so constructed would, when driven at a sufficiently high speed, rise evenly over the water, so as to skim over it. Further trials proved the superiority of five or six inclines over the lesser number. From the results of his experiments Mr. Ramus calculates that 5,000 horse-power will give to a 2,000 ton ship any speed up to 60 knots an hour. Having employed rockets as the propelling power in his experiments, the idea was suggested of using the vessel as a rocket float. Mr. Ramus estimates that a 100 lb. rocket would be capable of driving a float of one ton displacement at a hundred knots an hour to a distance of two miles. This float, he adds, would carry quite half a ton of explosives, and it is at least very doubtful whether the sides of any iron-clad would resist the shock of the explosion that would take place on contact.

NOVELTY IN SHIP-BUILDING.

AT East Boston, Mass., there has been built by N. Gibson, as an experiment, a three-masted schooner without frame. The vessel is 138 feet long, 32½ feet beam, and 12 feet 2 inches depth of hold. Long, sharp, large capacity and buoyancy. The vessel is composed of square logs of spruce, one foot square, placed one upon the other, and secured together by iron bolts three feet long, and placed twelve inches apart. The owner expects that this vessel will prove to be stronger, more capacious, and faster than vessels of the ordinary construction. In timber there is a saving of 40 per cent. Twenty-six tons of iron were used.

COMBINED SCREW AND RUDDER.

THE propeller and that portion of the shaft beyond the universal joint is hung in a composition frame, which takes the place of the ordinary rudder. A line passing through the axis of motion of the pintles and gudgeons would also pass through the centre of the ball of the universal joint; and by means of the frame, the propeller is thrown to the right and left in steering. My invention, says Lieut. F. M. Barber, U. S. N., has been applied to one of our torpedo launches at Newport, R. I., and has been in operation for several months. The speed of the boat is exactly the same as it was with the same propeller fitted in the ordinary way ; while the rapidity with which she can turn to starboard or port is very much increased, the diameter of her circle being much decreased. The rudder framehead is fitted with an arc, which gears into a rack on the side of a cylinder moving athwart the stern of the boat, so that she can be steered by steam or compressed air. An ordinary wheel is, however, fitted, which answers every purpose in a small launch, as it requires very little force to throw the propeller from one side to the other.



THE HOTCHKISS MARINE LOG.

THE self-registering log, made by Captain Truman Hotchkiss, of Stratford, Ct., consists of a sort of clock, which is placed on the taffrail or stern of the ship. A cord is then thrown overboard, to which is attached a small float that has feathers on its sides like a screw propeller. The feathers cause the float to revolve with a speed equal to the progress of the ship, and the float twists the cord which operates the pointers of the clock, and thereby shows at all times, day or night, the exact speed of the vessel in miles per hour, and also adds up and keeps account of the total distance traveled by the ship. We have received a letter from Captain Blakeman, commander of the large steamship Isaac Bell, plying between New-York and Richmond, who states that this log has been for a considerable time in actual use on that steamer, with entire success. He informs us that during six

passages between the Highlands of Neversink and Cape Charles, the log indicated substantially the same distance, and corresponded in its showing with the government chart. Captain Blakeman considers it a valuable assistant and safeguard for navigation, and thinks that no ship, whether steamer or sailing vessel, ought to go to sea without the clock log.

THE GRAVITATION COMPASS.

A NEW mariner's compass, remarkably devoid of complication in its various parts, and very steady in operation,

has recently been invented by the Earl of Caithness, F.R.S., of London. The ordinary compass is mounted upon gimbals, that is to say, upon two axes at right angles to each other, for the purpose of allowing the compass-box the power of swinging freely in all directions, the necessary result being that the bottom of the compass-box is kept by the force of gravitation, parallel, to a great extent, to the plane of the horizon, while its mountngs move in various directions, as influenced by the motion of the ship.

The essential feature of the Caithness compass is that, instead of its being mounted upon gimbals, it is mounted upon the top of a pendulum, which swings in a ball and socket joint.

The new Caithness compass consists of a ball close underneath the compass box, working in a socket fixed at the top of a conical support. The pendulum is about two feet in length, and is attached to the small ball, which has thus the power of giving a perfect rotation. It works in a perfect circle, and it does not matter how much the ship rolls. The Earl of Caithness calls it the gravitation com-

pass, because the pendulum always points to the centre of the earth. He says that it will bear very great rolling and pitching of the vessel—in fact, a roll of more than thirty degrees.

A TRIPOD BOAT.

A NOVEL boat velocipede was lately tried on the Allegheny River at Pittsburg. The machine consisted of three floats, each three feet long by 15 inches diameter, two of the floats placed side by side, a short distance apart; the other a steering float placed in front, like the front wheel of a velocipede, and made movable. A seat on slender rods rising from the two central floats supported the operator. Between the two floats were a pair of 8-inch paddle-wheels, worked by cranks from the driver's seat, where the front steering float was also operated. This novel machine, when set in motion, carried its inventor safely across the river.

SAFETY SHIPS.

MM. CROUZET and COLOMBAT have just brought before the notice of the Paris Academy a method for rendering ships insubmersible, through a new application of compressed air. They propose that the hull be divided into two parts by a bridge across the water line, in such a way that air cannot penetrate from the lower to the upper part. If a hole be made in a hull through a collision, the water will immediately enter; but it will not wholly fill the lower compartment, for the inclosed air, not having any outlet, will be compressed, and will ere long equilibrate the external force. From this moment the ship will cease to sink. It will, in fact, be in the position of a diving-bell.

IMPROVED CONSTRUCTION OF VESSELS.

EMPSON E. MIDDLETON, Southampton, England.—This invention has for its object to increase the capacity of vessels for carrying cargo or ballast, to enable them to carry more canvas, to improve their sailing qualities, and to make them safer in rough weather and in heavy gales of wind. The invention consists in the arrangement of the stern-post of yachts and other vessels with its lower end inclined to the rearward at an angle of 45°, more or less, in connection with a corresponding rearward extension of the keel.

DURING the past ten years, the screw has entirely replaced the paddle in transatlantic navigation, the weight of marine engines has diminished one half, the steam pressure has quadrupled, and the consumption of coal has decreased two-thirds.

NEW METHOD FOR RAISING SUNKEN VESSELS.

SOWERBUTT'S improvements, an English invention, are as follows: A number of pontoons and casks from 3 feet to 20 feet long, and from 3 feet to 12 feet in diameter, strongly made and sufficiently heavy only just to sink when filled with water, are attached to the sunken ship by a strong chain. Each of the pontoons contains a metal receiver filled with compressed air, sufficient when expanded to fill the pontoon at a pressure to be regulated at will. The pontoons, having been lowered to the wreck from a tug, are attached by divers to the ship. If necessary, other smaller pontoons or casks, constructed on the same principle, may be stowed in the hold or cabin of the ship. In each of the pontoons there is a tap—which may either be turned by the divers or by self-acting mechanism—by means of which a valve is opened in the receiver, and the air thus set free expels the water from the pontoon; and the required buoyancy having been obtained, the ship rises to the surface, whence it may be towed into harbor. There are several obvious advantages in this system. The invention brings into operation a natural principle, simple and certain, and the water is expelled from the pontoons without employing pumping apparatus at the surface; and the pontoons being filled on shore, all that remains to be done is the arranging them about the wreck, which, from their extreme lightness under water, is a matter of little difficulty.

IMPROVEMENTS IN RAISING WRECKS.

IN raising sunken vessels, it has been common to use flexible air-tight bags, which, when properly secured to the vessel, are inflated with air by pumps. A recent improvement, by Mr. Sowerbutts, of England, consists in supplying acid and alkali to the bags, which, on being mixed, generate carbonic acid within the bags and produce the necessary inflation, no air-pumping being necessary.

PRESERVATION OF IRON SHIPS.

EXPERIMENTS having shown that the destructive action of bilge water on the iron frames, etc., of iron and of composite vessels, may be reduced or altogether obviated by the use of lime, the British Admiralty directs that in all cases where it may be found impossible to dry out completely any of the compartments, bilges, or wings, in order to coat them with composition paint or cement, lime well slacked is to be placed in the water contained in such places. As unslacked lime would injure coatings of composition, paint, or cement, care is to be taken that the lime used is thoroughly slacked.

TOWING CANAL-BOATS.

AN application of steam to the towage of canal-boats, somewhat analogous to the foregoing, is by G. S. Olin. He uses a light steam-tug carrying a rope drum on deck, one end of the rope to be attached to a train of boats. The tug steams rapidly ahead, paying out the rope, then drops pole anchors, and winds up the rope, drawing the boats along at a good speed. The tug then starts ahead, unreels the rope, and, before the boats have lost headway, begins to wind up the rope again. In this way a small tug of light draft, burning but little fuel, may successfully tow several hundred tons of freight through the canals, at the required average velocity of 3 miles per hour. This method appears capable of being worked out into a valuable system of canal navigation.

THE TAY BRIDGE.

THE firm of Hopkins, Gilkes & Co., of the Tees Side Iron Works, Middlesbrough, England, have entered into a contract with the North British Railway Company for the completion of the great engineering work known as the Tay Bridge, near Dundee. This, when finished, will be the longest bridge over a running stream in the whole world. The total length will be 10,321 feet, or nearly two miles, so that it is 1,127 longer than the Victoria Bridge, Montreal, which is 9,194 feet in length, and has hitherto claimed the distinction that will henceforth be awarded to the Tay Bridge. There are, of course, bridges of considerably greater length than either, although none spanning a tidal river. There is, for example, the Tensas and Mobile Bridge, on the Mobile and Montgomery Railway, which is fifteen miles in length; but the greater part of this bridge is carried over great morasses, where the engineering and other difficulties to be surmounted were not at all comparable to those met with in this case; and even after our American cousins have got all due credit for the big things they have done in this direction, the fact will still remain that the Tay Bridge is, in its way, perhaps the most remarkable structure in the world.—*Newcastle Chronicle.*

RAILWAY OR SEA ALARM.—Air is compressed in a cylindrical reservoir from which a tube conveys it to three organ pipes (giving *do, mi, sol*), which can be sounded separately or together. In fog the *do* is sounded; and whenever an engine driver hears it in an advancing train, he sounds his *mi*, then the other driver sounds his *mi* if he is on the right line, then both sound *sol.*

OPENING OF THE ILLINOIS AND ST. LOUIS BRIDGE.

THE final test of the strength of the St. Louis Bridge was made on the 2d of July, 1874, under the supervision of Capt. J. B. Eads, the chief engineer. He was assisted by Col. Henry Flad, Oscar Scheultze, Messrs. Klemm, Varrelman, Schmidt, Cooper, and Devon, with ten assistants, and Mr. Schaler Schmidt, of the Baltimore Bridge Company. Col. H. B. Carrington, United States Army, Professor of Dynamic Engineering at Wabash College, was also present, and expressed his satisfaction at the result of the tests. At a given signal there were fourteen locomotives ready to obey the command of Capt. Eads and Col. Flad, and their assistants. At about 10 o'clock seven locomotives, crowded with people on pilot, cab, and tender, moved in a body coupled together, and ascended the approach; and when arriving on the two 56 feet spans over Front street and the levee, east of the abutment pier, they halted, and by a signal notified the other caravan of seven iron horses to come up to the rack; and they followed up, and the test was begun in earnest.

The following is Capt. Eads' summary of the result of tests made upon the Illinois and St. Louis bridge with fourteen locomotives:

Seven locomotives were placed upon one track of each span. This produced a deflection of 2¼ inches on centre span, and 2⅛ inches on each side span. Seven locomotives were then placed on each track of the west approach, and both trains of locomotives, fourteen in all, were moved out abreast and simultaneously over each one of the three spans. The locomotives weighed from 35 to 51 tons, averaging 40 tons each, making 560 tons in all. The two trains thus formed were stopped on each span, and the effects of this load carefully noted. The deflection of the middle span was 2¼ inches; of each side span, 3 inches. The two trains moving abreast upon each arch was the severest possible test to produce distortion of the curve of each arch. Ten locomotives were then coupled together, and these were run over each track on each side of each arch of the entire bridge, covering the entire track of each span, and throwing the whole weight of the train, 400 tons, on one side of each span. This test was applied to each side of the bridge, and produced the severest twisting strain to which each arch can be subjected. The vertical deflection produced by this test on the centre span was 2⅛ inches. The locomotives thus coupled were run at a speed of ten miles per hour. The local

traffic on the upper roadway of the bridge was uninterrupted during the progress of the tests. Various other observations in detail were made, noting the effects of the load on the arches as it entered upon and left the different spans, but this possesses no special interest to the general public. The result of the tests agreed almost exactly with the theoretical computations previously made, and the whole trial proved eminently satisfactory. The instruments failed to detect any side motion whatever during the tests."

The river is spanned by three arches, of which the central arch has a span of 520 feet, the other two of 502 feet each. The arches are composed of cast-steel, and the bridge is really a double structure, consisting of two arches placed side by side. The arches are made of steel tubes, each twelve feet in length.

The formal opening of the bridge was celebrated on the 4th of July, with great enthusiasm. The display was finer than ever before witnessed at St. Louis. The procession was five hours in passing a given point. Addresses were made by Mayor Brow, ex-Senator Gratz Brown, Governor Woodson, of Missouri, and Governor Beveredge, of Illinois.

THE St. Louis Bridge has a total length of 4,462 feet, as follows: From Third street to the building line on the levee, 930 feet; thence to building line in East St. Louis, 2,107 feet; thence to commencement of the eastern approach on the dyke, 1,425 feet. This approach is 2,000 feet in length.

IMPROVED ELECTRIC RAILWAY SIGNAL.

PAUL TESSE, HENRY LARTIGUE, AND PIERRE D. PRUD'HOMME, Paris, France.—This invention is a semaphoric mast, to the top of which are pivoted two large arms fulcrumed so as to hang vertically, said arms being attached to the cranks of two similar electrical apparatus below by a traction rod. Just below these two large arms are two small ones, fulcrumed to said mast so as to hang horizontally, and connected, each by traction rods, with separate electrical apparatus similar to the first mentioned. The whole line consists of a series of these masts provided with arms and electrical apparatus, said arms being disposed vertically along the mast when not in use, and the electrical apparatus of the large arms of one station being connected by wires with the electrical apparatus of the small arms of the second station, etc. The large arms are locked or presented horizontally to the gaze of the engineer mechanically, by moving a crank of the electrical apparatus. Said motion, also, by means of a commutator,

brings into play a battery, which, by communicating with the electric apparatus of the small arms of second station, allows them to fall horizontally. The mechanical effect of said fall, through a commutator and battery of second station, sends a current back to first station, which acknowledges, upon a bell and an annunciator at first station, the receipt of the original signal sent from said first station. By means of this arrangement, the large arms of a mast at the first station serve as a signal to an approaching train, and the elevation of them notifies the agent at second station, through the electrical apparatus, battery, wires, and small arms of mast at second station, of the passage of the train past the first station. After the train has reached the second station, the agent there allows the small arms of his station to fall, which mechanical action, through a commutator and battery of the second station, allows the large arm of the first station to fall. Said fall, through the commutator and battery of first station, sends another current to second station, which acknowledges, by a bell and annunciator, the receipt of original signal, and announces the fact that the large arm of first station has fallen. This combined electrical and mechanical apparatus is situated in between the two tracks, one large arm and one small one on same side of the mast being used for the trains passing up, and the other large arm and small arm on the opposite sides for the trains passing down.

CAR AXLES AND BEARINGS.

AT a recent meeting of the Car-Builders' Association, discussions took place in regard to Mundy's friction roller journal box. In this device, the roller, six inches in diameter, turns on a solid spindle, the bearing of the roller being the whole length of the spindle. It was claimed that this was better than the ordinary plan of making the spindle and roller in one piece. The improved arrangement, it was claimed, provides a larger bearing, and prevents the escape of oil therefrom.

Mr. Garey described the following experimental tests which he had made of the power required to move cars with different sized journals: A passenger-car with 3¼-inch journals, and weighing 44,674 pounds, required a force of 800 pounds, as shown by a dynamometer, to move it along a level track as slowly as the engine could be made to move. The car was in good running condition and the journals well fitted. Another passenger-car, which was new and had run only 90 miles, weighing 46,770 pounds, and with 3⅜-inch journals, required just 700 pounds, as indicated by the same instrument, to move it on the same

track and in the same way as the other; thus showing that 100 pounds less force was required to move the heaviest car with the large journals. Specimens of the Ainsworth friction metal bearings were shown, one of which was stated to have run 40,363 miles under a Pullman car without heating. The metal is claimed to be 25 per cent cheaper than brass, three times more durable, and requires 50 per cent less oil.

Mr. D. A. Hopkins called attention to the advantages of lead-lined bearings. They had been tried under heavy palace cars, and had run 58,000 miles without heating or wearing out. The lead should not be more than 1-16th of an inch in thickness; it then accommodates itself to the journal, and gives a true bearing; but if thicker, will be pressed out at the sides and ends. (122)

STREET CARS PROPELLED BY SPRINGS.

THE winding up of the spring barrels, which are carried under the car, is effected by engine power, located at suitable intervals along the track, as may be convenient for the run. The stationary engine drives by belt the horizontal shaft, carried in bearings, inclosed in a metallic tube or casing, beneath the roadway, and extending across the track; close alongside whereof a covered box is sunk in the roadway, inclosing a wheel so shaped as to connect with the winding axle of the tramway car, and thus give the requisite motion thereto. On the arrival of a car at any station, the spring barrels are quickly wound up by the engine.

It has been computed that the actual tractive force requisite to overcome the resistance of a street car weighing 5 tons gross, is 60 lbs. on the driving wheels, corresponding to 720 lbs. on the periphery of the spring barrel; 24 lbs. and 288 lbs. respectively correspond to a gross weight of two tons; and in like proportions for intermediate weights. So far as previous experience goes, a spring 6 lbs. in weight, exertng a direct pressure of 105 lbs., may be taken to represent the maximum in size and power of such steel springs. Under the stimulus applied by M. Leveaux's researches, the steel manufacturers of Sheffield, by special and improved plant, annealing ovens, and appliances, have turned out springs 50 to 60 feet long, capable when duly coiled of exerting a pressure of 800 lbs. to 900 lbs., without permanent set. In France, also, steel driving bands, with great elasticity, are made 100 yards in length, so that the question of the possiblity of obtaining springs of the requisite size and power is practically solved.

M. Leveaux has had all the necessary mechanism and appliances made by a well-known firm of engineers, so as to fit up a tramway car or cars for actual trial upon some of the lines of metropolitan tramways in London; for which, indeed, the arrangements are now nearly complete, so that the practical working of the system will speedily receive a thorough public demonstration. We have ourselves had opportunities of seeing the potentialities of the prnciple, both in the model and full working size; and, even in view of the sweeping change in the tramway system which is involved in its complete success and adoption, we can not withhold the conviction that all the important practical difficulties have been effectually surmounted, reducing its practical realization to mere matters of detail. The working of the springs is entirely free from noise, perfectly smooth, easy and effective, and completely under control, for application, cessation, and reversal. (106)

THE largest locomotive in the world is the Janus, which was built at the celebrated Mason Machine Works, Taunton, Mass. The Janus has four cylinders, 15x22, and twelve drivers, 3½ feet diameter, and no other wheels. Its weight, when the tanks and coal bunkers are full, is 84 tons. It is now working on a coal road in Pennsylvania.

NEW IRON PERMANENT WAY.

A SYSTEM of iron permanent way has been recently designed and introduced on the Nassau State Railway, in Germany, by Mr. Hilf. About 65 miles of line have been laid, and we understand that the cost of maintenance has been scarcely one-third of that for ordinary permanent way. The invention consists in iron longitudinal sleepers to which the rails are secured, the gauge being maintained by the bolts passing through the web of rails. The latter, shown in section in our engravings, are of Bessemer steel, and for the Nassau railways were made in lengths of 19 feet 8¼ inches each, weighing 48 lbs. to the yard.

The mode of fastening rails and sleepers is clearly represented in Fig. 1. The former are notched only at the ends and are secured by a bolt, *a*, placed on one side to avoid longitudinal displacement; *b* is the tie rod, two of which per length of rail are used. The entire structure weighs 232.64 lbs. per yard, and its entire cost, in Europe, is estimated at about $7.50 per similar distance. In Fig. 2 is represented the drainage adopted in connection with the system.

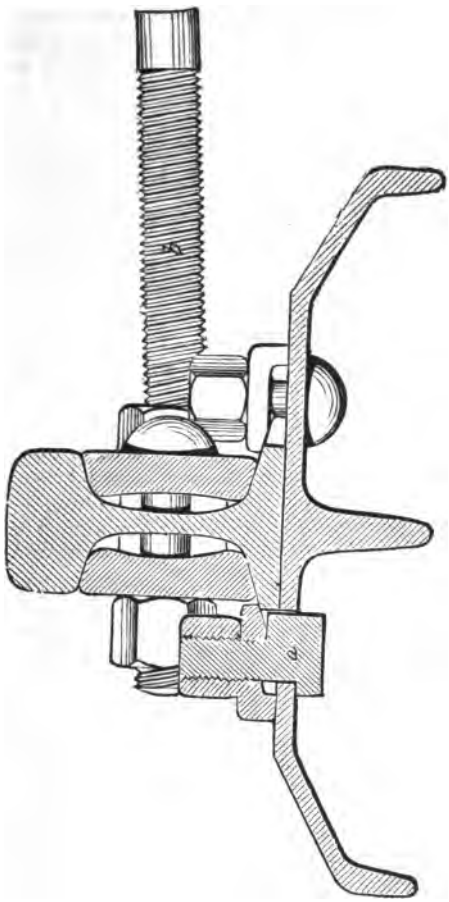


FIG. 1.—HILF'S IRON PERMANENT WAY.

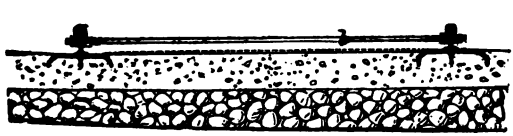


FIG. 2.

RAILROAD TRAIN-TIMER.

AN ingenious invention has lately been successfully tested on the Vandalia Railroad, Ind., which records the motion of railway-cars. There is a locked iron box, attached to one side of the car, and containing a clock. The mechanism of the latter causes a small drum, on which is wound a sheet of paper, to travel at a constant rate. With the axle, by means of rods and gearing, a pencil touching this paper is connected. As the pencil is moved slowly across the paper by its mechanism, governed by the axle, and as the paper is slowly moved forward, the pencil-point inscribes a diagonal line back and forth. The paper is ruled in very small sections, every fourth line being dotted and representing one mile, so that, supposing the car goes a mile in four minutes, the line will cross just four sections diagonally from one dotted line to the next one. If the car stops, the line crosses the paper directly and shows the number of minutes that the train is at rest.

The names of the stations are written at the proper places on the paper, and thus the exact rate of speed made at any point on the line can be subsequently noted. The apparatus thus affords an excellent check on the train officials, as, if the train be run ahead or behind time, the fact is sure to be detected.

THE FIRELESS LOCOMOTIVE.

MR. RICHARD H. BUEL, a well known consulting engineer, of New-York, has published an account of a trial trip with one of the engines of the Fireless Locomotive Company.

The locomotive with which the experiment was made consists of a platform set upon a four-wheeled truck, carrying a cylindrical reservoir 37 inches in diameter and 9 feet long, with a steam dome 1 foot in diameter and 2 feet high. The steam space of the reservoir is connected with a pair of vertical engines, each having a diameter of 5 inches and a stroke of 7 inches; a 2-inch pipe, perforated with small holes, runs the whole length of the reservoir, near the bottom. In charging the reservoir this pipe is connected with the steam space of a stationary boiler, and steam is admitted until the pressure in the boiler and the reservoir are the same. The locomotive is then ready to run, and will continue to move until the water in the reservoir has cooled down so much as to be incapable of furnishing steam of a working pressure.

In making the trial trip, the pressure in the reservoir at starting was 142 pounds per square inch; and at the end of 49 minutes, during 35.5 of which the engines were in

motion, it had fallen to 22, giving a mean pressure during the run of 81.5 pounds per square inch. At the start, the reservoir was half full of water. Indicator diagrams were taken during the run, and such *data* were noted as were possible. From these, it appears that the whole distance run was about 4.5 miles; the average horse-power developed by the engines was 3.61, and the number of pounds of water evaporated in the reservoir, calculated from the indicator diagrams, 147. The writer then shows that if the engines had been designed in accordance with the best modern practice, the distance run by the locomotive, with this same evaporation, would have been from 2 to 2½ times as great. A calculation is then given, showing that, with a reservoir of the same size and engines about one and a half times as powerful as in the actual case, starting with a pressure in the reservoir of 275 pounds per square inch, and ending with a pressure of 20, the locomotive might be expected to continue in motion for nearly six hours before the reservoir required recharging.

LOCOMOTIVE FOR STEEP GRADIENTS.

THE invention of Henry Handyside, of London, consists in attaching a drum and traction-rope to the bottom of the locomotive or tender. When the train reaches the foot of a steep grade, the engine is uncoupled from the train and runs up the grade, paying out the rope, one end of which is attached to the train. On reaching the summit the locomotive is locked to the track by means of a pair of griping levers, steam is applied to the drum, the rope wound and the train drawn up. By the use of this simple and cheap attachment, Mr. Handyside shows that any ordinary locomotive will readily draw the heaviest trains up grades of one foot in ten, or 528 feet to the mile, and he therefore proceeds to point a few of the advantages that would result in railway construction by the adoption of his plan of operation, among which are the following:

Saving in first cost of survey. Saving on embankments. Saving on face cuttings. Saving in the length of tunnels. Saving in the length and height of viaducts. Materially shortening all lines which have high land between their extremities. A corresponding saving in length of rails. Any locomotive capable of hauling a given weight up a gradient of say 1 in 50 to be capable of hauling the same load up 1 in 10 or even 1 in 8. A much lighter class of locomotive necessary. A corresponding reduction in weight of rails. Simplicity of construction, inexpensive, and not easily deranged. Less friction and wear and tear on all steep gradients, of say 1 in 10, than on the generality of gradients now in ordinary use. No break of gauge

necessary, and applicable to any gauge. Especially applicable to tramways, which as feeder lines will often penetrate into hilly districts. The carrying power along the whole line not limited by the frequent occurrence of steep gradients.

THE RAILWAY ROLLING STOCK OF THE UNITED STATES.

THE return of railway rolling stock, as given in *Poor's Manual* for 1874–5, on the roads of the United States and Canada, are as follows:

Passenger-cars of all classes	2,990
Baggage, mail, and express cars	4,157
Box, merchandise, and house cars	87,009
Platform, gondola, and flat cars	52,198
Stock-cars	14,222
Coal-cars (number of wheels not stated)	66,887
Four-wheel cars (mostly coal)	37,892
Caboose-cars	1,549
Oil-cars	3,154
Ore-cars	2,102
Lumber-cars	193
Freight-cars not classified	94,694
Total	373,959
Locomotive engines	14,939

Deducting from these aggregates 774 engines and 13,980 cars of all classes, as returned by the Canada roads, leaves for the roads in the United States a total of 14,165 engines and 359,979 cars, exclusive of what are denominated service-cars, and exclusive of narrow-gauge cars.

RAILROADS IN EUROPE AND AMERICA IN 1873.

	Railr'ds, Miles.	Population.	Area, Sq. Miles.
United States	71,565	40,232,000	2,492,316
Germany	12,207	40,111,265	212,091
Austria	5,865	35,943,592	227,234
France	10,333	36,469,875	201,900
Russia in Europe	7,044	71,207,794	1,992,574
Great Britain, in 1872	15,814	31,817,108	120,769
Belgium	1,301	4,839,094	11,412
Netherlands	886	3,858,095	13,464
Switzerland	820	2,669,085	15,233
Italy	3,667	26,273,776	107,961
Denmark	420	1,784,741	14,453
Spain	3,401	16,301,850	182,758
Portugal	453	3,987,867	36,510
Sweden and Norway	1,049	5,860,122	188,771
Greece	100	1,332,508	19,941

OIL TANK CARS.—On the Atlantic and Great Western Railroad, these tanks are made of three-sixteenths iron, and are sixty-one inches in diameter. They hold eighty-five barrels. They resemble cylindrical boilers; are fitted with man-hole, dome, filling and draw-cocks, and are strapped down to platform cars by means of plate-iron bands. The arrangement is cheap, safe, simple, and dura-

ble. Pipe lines leading from the wells to the railroad stations convey the oil, which pours directly into the tank cars.

THE St. Louis Underground Railway Tunnel is 4,800 feet in length, and extends from the great bridge to Poplar street.

PAVEMENTS.

AN investigation has been conducted in England by Mr. William Haywood, engineer and surveyor to the Commissioners of Sewers of the city of London, which mainly consisted in observations as to the number of accidents befalling horses on asphalt, wood, and granite pavements. The investigations extended over fifty working days, and were principally made during the rainy weather of spring. The granite was found to be most slippery, the asphalt next so, and the wood the least. Considered in respect to moisture, asphalt was most slippery when merely damp, and safest when dry; granite most slippery when dry, and safest when wet; wood most slippery when damp, and safest when dry. Wood, on the whole, is less slippery than either asphalt or granite in a marked degree, it being only inferior to granite when the pavements were wet, and the difference then between the wood and the granite being considerable. Of the accidents most obstructive to traffic, as well as most injurious to horses, asphalt had the greatest proportion, granite next, and wood least.

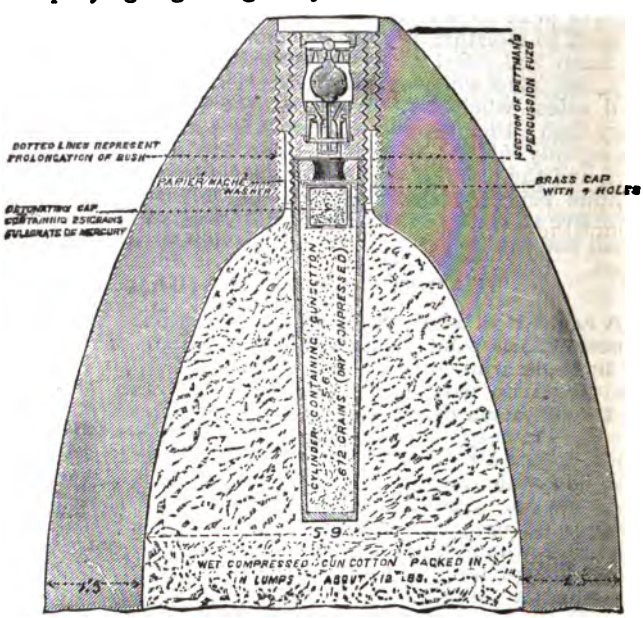
ROAD-BUILDING IN INDIA.

A PAPER read before the London Institution of Civil Engineers shows what prodigious difficulties are encountered by those who construct roads in the hill country of India, where no earth-work will resist two rainy seasons. In the Himalaya the annual rain-fall amounts to two hundred and twenty inches, and at times five inches fall in an hour; hence a road, unless constructed of the best material, and with due precautions, may be washed away at short notice. Above eight thousand feet, the snow must be guarded against. In one place an avalanche half a mile long and a hundred feet thick came down, carried away a stone bridge of forty feet span, and remained unmelted six months. Experience has shown that where forests prevail it is best, though with more labor, to cut the road through the forest, because the trees break the force of the rain, and the mould beneath passes the water gently away; whereas, on a bare hill-side the rush of water would sweep everything before it. Sometimes a road is required along the face of a vertical cliff; and a shelf is erected, or a half-tunnel is blasted out, which, with the shelf,

makes a sufficient thoroughfare. Where wood is plentiful, it is found more expeditious to heat the rock by great fires, and then flood the hot places with water, whereby the rock breaks away in large masses, and with far less trouble than in blasting. In the preparation of a preliminary gangway along the face of the cliff, there is abundant room for the exercise of ingenuity, for it involves the problem of standing on nothing.

WET GUN-COTTON SHELLS.

A NEW explosive for shells has been recently tried by the British War Office authorities. It consists of a shell loaded with wet gun-cotton, which explodes when properly fired with as much force as dry cotton. The arrangement of Professor Abel's is shown half full size in the accompanying engraving of a 9-inch shell. The burster was


DOTTED LINES REPRESENT PROLONGATION OF BUSH
PAPIER MACHE WASHER
DETONATING CAP CONTAINING 25 GRAINS FULMINATE OF MERCURY
SECTION OF PETTMAN'S PERCUSSION FUZE
BRASS CAP WITH 4 HOLES
CYLINDER CONTAINING GUNCOTTON 672 GRAINS (DRY COMPRESSED)
5·9
WET COMPRESSED GUN COTTON PACKED IN LUMPS ABOUT 1/2 LBS.
7·5
2·5

PROF. ABEL'S WET GUN-COTTON SHELL.

5½ inches long, and contained 672 grains of dry compressed gun-cotton. The detonating cap consisted of 25 grains of fulminate. In order to determine whether 9-inch

shells fitted with these bursters would withstand the shock of discharge, several rounds were fired filled with water. The cylinders were crimped on to the bases of dummy Pettman's percussion fuzes. All exploded prematurely in the gun, thus plainly showing that the use of water in bursting 9-inch shells must never be contemplated. Similar shells were then filled with wet paper pulp, and the attachment of the burster being slightly modified, several rounds were fired with the most perfect success.

This point being also satisfactorily decided, it only remained to ascertain the effects that would be produced as to breaking up and dispersion by the exploding of a 9-inch shell fitted with such bursters, but having the paper pulp replaced by wet compressed gun-cotton. Accordingly, a boarded inclosure was contrived upon the sands at Shoeburyness, within which several of these projectiles, packed as tightly as possible with lumps of wet gun-cotton, and fitted with the burster before described, but having merely a plug screwed into the fuze-hole above it, were fired by means of an ordinary electric fuze through a hole in the plug. Some 10 lbs. or 12 lbs. of gun-cotton were packed into each shell. The result was marvelous. The shells burst literally into thousands of pieces, some portions being propelled to a distance almost in the condition of powder! It was, indeed, nearly impossible to count the fragments. In short, the effects produced by these experiments far exceeded the most sanguine anticipations of the Committee on Explosives, and clearly point to the following conclusion, namely: That in actual warfare against troops their effect would be considerably more disastrous than that of 16-pounder common shell charged in the ordinary manner, the number of fragments produced being far greater, and the cone of dispersion of those fragments being quite as efficacious. (61)

COMPRESSED GUN-COTTON.

A SERIES of experiments is in progress at the Royal Arsenal, Woolwich, Eng., with a view of further elucidating some of the various attributes and characteristics pertaining to compressed gun-cotton. Interesting facts as to the extraordinary rapidity of detonation of gun-cotton were brought to light about a year ago. It was ascertained that this was unprecedented, the swiftness of the action being marvelous; indeed, with the exception of light and electricity, the detonation of gun-cotton traveled with greater rapidity than anything we are cognizant of. Thus, detonation would take place along a line of compressed gun-cotton discs, placed so near as to touch each other,

with a velocity only inferior to that of electricity or light, igniting a charge or conveying a signal, if desired, almost instantaneously; 20,000 feet, or nearly three miles per second, was calculated to be the rate of transit, according to Noble's electro-chronoscope. A powder quick-match of the most delicate construction ignites so leisurely that the process can almost be observed with the eye. Now, comparing the velocity of detonation of gun-cotton with some other speeds, we find that it is eighteen times greater than that of sound, fifteen times greater than that of a rifle bullet, and actually one hundred and eighty times superior to that of the swiftest express train. One important characteristic in the detonation of compressed gun-cotton is its power of self-transmission, unimpaired in violence and vigor of action, through a continuous train of discs. It is carried on from one disc to another, each in its turn being acted on by its neighbor behind, and setting up a similar action on its neighbor in front.

The present experiments are to determine the relative effects of the detonation of various classes of gun-cotton, nitrated and common, when performed in the open air. A "crusher-gauge" has been employed. It consists of a cast-iron body with an orifice at the top, into which a socket is screwed. Within this a piston works up and down, which is recessed around for packing. Pellets of copper are placed upon an anvil beneath the piston, and they are kept in position by a little india-rubber washer placed around them. The crusher-gauge is then securely screwed to a large wrought-iron plate at its three corners. The pellets employed are cylinders of copper $\frac{1}{4}$ inch high, diameter 2.306 inches, and area, $\frac{1}{12}$ inch. The means adopted for determining the amount of pressure exerted upon the piston by the shock of an adjacent explosion are by measuring, with a delicate micrometer, the extent to which the pellets are compressed. Several 5 lbs. charges of compressed gun-cotton were detonated, each at about a foot's distance from the crusher-gauge, and in the open air. In some instances the compression of the copper pellets was equal to $3\frac{1}{2}$ tons per square inch.

The concussion given to the air, then, by the detonation of a large mass of gun-cotton must be simply prodigious. But we were prepared to find that it was extreme from observations taken during experiments recently instituted at the Arsenal with discs of gun-cotton detonated upon wrought-iron slabs, $1\frac{1}{8}$ anches, $1\frac{1}{4}$ inches, and $1\frac{1}{2}$ inches thick. Although loosely placed upon the slabs, with only a light tamping of sand over them to keep the detonating fuze in position, and not in any way confined, upon

firing the charges, consisting of ½ lb. compressed gun-cotton, the slabs of iron were split into fragments. Moreover, a band of discs placed around the trunk of a large tree at Upnor, and detonated, severed it instantaneonsly, as though felled by a single blow from an ax. (61)

THE SCZAROCH.

THE Russians have lately adopted a new shell, which, according to recent experiments, seems to be a formidable projectile. It is well known that with the ordinary elongated bolt a ricochet fire can not be maintained; and as this species of firing is very effective against masses of troops, the loss is a matter of considerable moment. The sczaroch, for such is the name of the new projectile, is either a percussion or time shell and a shot, the latter of which ricochets beyond the point of explosion of the bursting charge. The shell portion is a simple iron cylinder, to one end of which is secured, by a thin sheet of lead, a spherical shot.

On leaving the gun the combined projectile acts like an ordinary elongated shell; but as soon as the explosion of the charge takes place, the cylinder of course flies in pieces, while the shot, impelled by the additional velocity and by reason of its form, ricochets for hundreds of feet ahead. In firing at batteries, the double effect of this projectile comes into excellent use, as the shell might be exploded among the guns, while the ball would strike far in the rear among the reserve troops; or, while the shell might burst in the front rank of an advancing column, the ball would continue plowing its way through several succeeding ranks.

AN EIGHTY-TON GUN.

THE principle upon which English guns are now made is that discovered by Colonel Fraser. Briefly, it consists of a series of coils, welded together in such a way that the grain of the iron is best opposed to the explosive force of the powder, and encircling a steel tube, the interior of which is rifled. A long bar of iron—say of eight inches square—previously prepared, is slowly drawn from a furnace, to a length of about 300 feet, and wound in a double coil in the form of a cylinder. This is again heated and placed beneath a steam-hammer, where it is welded together by tremendous blows, which so effectually do their work that a cylinder capable of bearing the greatest possible strain is formed at a comparatively trifling expense. Several of these coils being made, they are placed in order upon a long steel tube which has been made in Sheffield, and the weapon is finally turned out at an average cost of

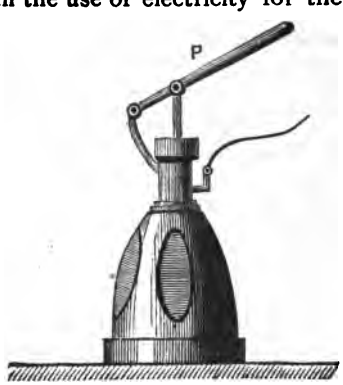
about $300 a ton, as against nearly $750 at Krupp's factory in Essen. Upon this principle, then, it was resolved to construct an eighty-ton gun, which should be able to pierce twenty inches of iron at a distance of a thousand yards, with a shot 1,600 pounds in weight, and by the aid of 300 pounds of powder. The length of this magnificent piece of artillery was fixed at twenty-seven feet, its diameter at the trunnion six feet, and at the muzzle sixteen inches, inside measurement. It was calculated that such a gun would be able to deliver its mischief-working missile at a distance of nearly ten miles, and that it would, at the same time, be easily placed in the turret of a war ship or the embrasure of a battery, and worked quickly and without difficulty.

VIGORITE.

THE account of trials of this newly discovered explosive at Stockholm, states that a charge of about eight ounces, made up in five cartridges and deposited in an excavation, raised a block of stone of 163 cubic feet. It would have taken over fourteen ounces of dynamite to have produced the same effect.

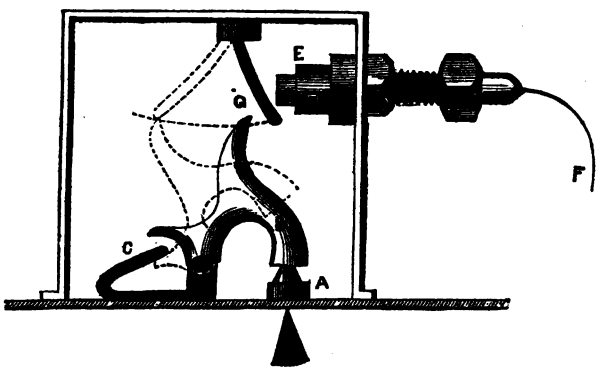
THE TOSELLI TORPEDO.

M. TOSELLI is an Italian inventor who does not believe in the use of electricity for the purpose of firing torpedoes or blasts. He says it is expensive, uncertain, and often perilous.



The substitute he proposes is force, transmitted to the firing mechanism through a fine hollow thread filled with water and acted upon by a powerful hydraulic press. This will be understood from our engravings, in which Fig. 1 is the press, of which P is the handle, and on the right the hollow wire is seen emerging. The diameter of the latter is about 0.06 inch. When this tube is once filled, one or two strokes of the piston, according to the inventor, are sufficient to determine an explosion. In Fig. 2, which shows the firing apparatus, A is the nipple, having a fulminating cap; B is the hammer, and C a spring by which it is actuated; D is

a cylinder in which moves the piston, E, through the power communicated through the tube, F. When the piston, E, is pushed forward, it strikes the spring level, G, push-



ing it inwards, and this, impinging against the hammer, raises it to the position shown in the dotted lines. The lever continuing its retrograde motion, the hammer slips from under it, and is carried by the spring forcibly against the cap, thereby causing explosion.

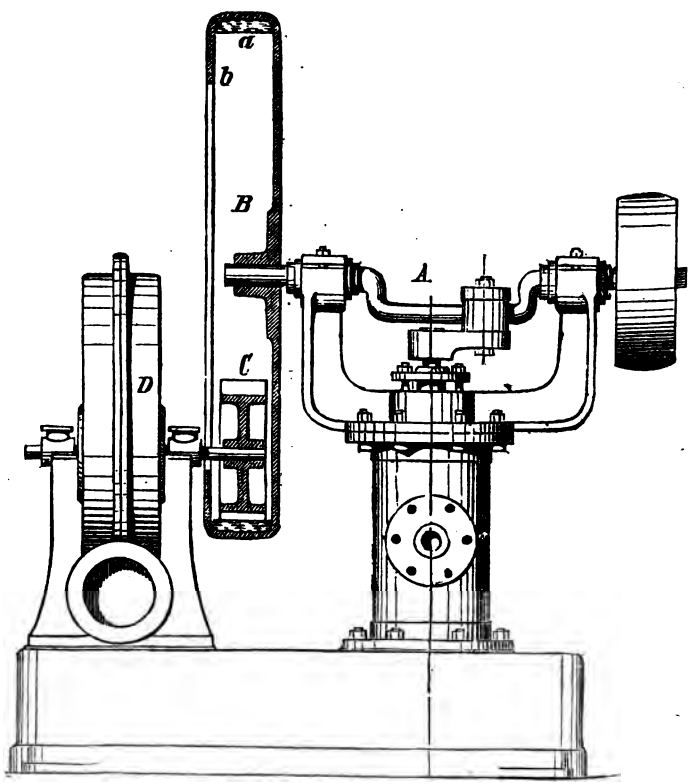
THE AMERICAN ARMY MUSKET.

THE report of the Ordnance Bureau for the year 1873 is a valuable document, especially interesting as containing the report of the board of officers appointed to investigate the different patterns of breech-loading muskets and carbines for the military service of the United States. All the various weapons submitted to them are figured in detail. About one hundred different American arms and a number of foreign, including the Chassepot, the needle-gun, the Martine-Henry, and others, were considered. After a very careful series of experiments, the Board came decidedly to the conclusion that the present Springfield gun, of all those examined by them, is really the best adapted to the military service, and they accordingly recommend that this be adopted.

The Elliot breech-loading carbine is recommended for mountain service; and of the several calibres of barrels brought forward that of 0 45 of an inch was preferred, as having more advantages than any other. This was accordingly proposed to the Secretary of War, and approved by him. It was also advised that the barrels of the muskets and carbines be browned.

WATER-BELT FOR TRANSMITTING MOTION.

A CURIOUS mode of transmitting motion by means of a water-belt is represented in the annexed engraving. The device is that of an English inventor, Mr. J. Robertson, and is said to work with perfect freedom from noise and vibrations. The piston of the engine is connected with the driving shaft, A, on one extremity of which is attached a large hollow pulley, B. The outer face of the latter is cut away from the centre so as to leave only a flange of the width shown at B. Through the opening passes the shaft of a fan blower, D, on which, and inside



the hollow pulley, is a pallet wheel, C. The pallets on the latter do not touch the inside of the hollow pulley.

In operation the water, A, of which a small quantity is

placed in the pulley, B, is caused, by centrifugal force, to spread itself against the inner periphery, and to be carried around with the wheel. Into this water, as shown in the sectional view on the left, the pallets on wheel C, dip, and are thereby acted upon by the force of the same, causing the wheel, C, to rotate. The hollow pulley is of sheet iron, and is revolved at the rate of 500 turns per minute. No water whatever, it is stated, is ejected from the apparatus, and it is only necessary to supply the small amount lost by evaporation to keep the device in working order.

A NEW MOTOR.

ACCORDING to the laws of the mechanical theory of heat, any difference of heat may be employed for produc-

BERNARDI'S THERMO-MOTOR.

tion of mechanical work. If a cold body, then, be situated in air that is hotter, the passage of heat to it should be capable of giving mechanical work. The solution of

this problem, M. Enrico Bernardi, an Italian physicist, has recently sought to realize in the following way:

Two similar glass balls are connected together by a thin glass tube, the ends of the tube passing into the balls being bent at a right angle. One ball contains a small tube, by which ether can be poured into the apparatus; the ether is brought to boiling, and, when all air has been expelled, this small tube is closed by fusing. The quantity of ether inclosed in the system should be such as to fill about three-fourths of one ball. At the middle of the connecting tube is fixed a piece through which passes a metallic axis, round which the system can turn. When the ether is equally divided between the two balls, the apparatus is in unstable equilibrium. The bearings for the axis are supported on the cover of a rectangular case, and in this cover is a slit through which the turning system passes. The case is filled with water, iuto which the balls dip alternately on their being turned round the axis. Each ball is covered with a very fine veil. It is easy to see that this apparatus will take a see-saw motion.

Owing to the unstable equilibrium of the system, one of the balls, A, sinks, and all the ether flows into it, while the rest of the space is filled with the vapor. The ball A is then in water, the ball B in air. Hereupon the moisture on the surface of B begins to evaporate, and the ball is so cooled that the vapor within condenses; from the ball A more ether is evaporated, and it is condensed in B, till at length B contains more ether than A, and sinks, while A rises; and the same process is repeated. This see-saw motion lasts as long as there is water in the case to moisten the surface of the under ball.

It would be rather troublesome to utilize this thermo-motor see-saw mechanically; and M. Bernardi has, therefore, preferred to alter the apparatus in the following way: The two balls of the above described system are connected by a tube, the ends of which are bent round (at right angles) to opposite sides. Three such systems are formed into a sort of wheel, the middle points of the six balls and the tube being in one plane. This wheel is supported at its axis, on the cover of a rectangular case, in such a way that, in its rotation it is always half within the case and half in the air. The balls are covered as before, and so much water is poured into the case that, in turning the wheel, one ball is always immersed. By giving the wheel a turn, it can be set in continuous rotation; and, with a suitable arrangement of pulleys, it can be made to raise a weight, or do other work.

Such a thermo-motor wheel has, for several months,

been working a clock in M. Bernardi's laboratory. The balls have a diameter of 0.78 inch; the distance of the middle points of two opposite balls is 3.1 inches, and the quantity of ether in each system fills three-fourths of a ball. The clock maintained in motion by this wheel consumes, in 24 hours, 0.2 of a foot-pound. The water level is, by a special arrangement, kept constant. M. Bernardi has had his see-saw working for three months without its becoming necessary to renew the water or clean the balls. He has calculated the quantity of heat which is removed by this apparatus from the surroundings. There was an average of 60 see-saw motions in 24 hours. This was found to be equal to 0.12 of a foot-pound, or about half the work consumed in the same time by the clock. (40)

KORTING'S CONDENSER.

WE notice that a Mr. Körting has invented and introduced a novel condenser, in which the work required to eject the condensed water is performed by its own velocity, instead of by the old-fashioned air pump and hot well. The condenser is of the old injector principle, in which the exhaust steam is admitted by various concentric cones around a stream of falling water. This disposition of parts causes the exhaust steam from any cylinder to offer a large surface to the cold water. Condensation is thereby effected, and a very considerable velocity is produced in the descending column of water. This causes a considerable vacuum behind the falling columns. In order to produce the required effect, it is necessary that the falling water should have a small initial velocity. In M. Körting's arrangement, the water has a velocity due to a head of 9.85 feet. The water is pumped up into a tank at that height by means of a pump attached to the engine; so that the power required to work this pump must be deducted from the effective gain of the condenser. The advantages of the apparatus are these:

First, its price is not more than from an eighth to a quarter of an ordinary condenser. Second, there is no need for any foundation, and consequently it is easily applied to existing engines or to new ones. Third, it works without air pump, which saves the loss of work and the inconvenience of setting up and of operation of the latter. Fourth, there is nothing to regulate, and, in consequence, it demands no particular care from the attendant. Fifth, as there are no moving parts (pistons, valves, etc.), there is no wear, repairs, or interruption in work. Sixth, its application is especially advantageous to small machines, where the inconvenience and the price of an air pump is very great.

THE STEAM JET AS A BLAST ENGINE.

CAPTAIN C. E. DUTTON, of the Ordinance Corps, in a communication on the subject of fuels, made to the Washington Philosophical Society, gives an explanation of the economy derived from using a steam jet to inject air under a fire. The vapor of water absorbs so much heat that theory would point to a loss rather than a gain from this method, while, as a matter of fact, the steam jet is in common use and with excellent results. Captain Dutton says: "These jets of steam are usually discharged from small nozzles under a very considerable pressure, and produce an intense agitation of the air. We might recall here the celebrated analyses of Sir W. R. Hamilton, and of Helmholtz, of the vortical motion of fluids and their demonstration of the remarkable persistence of vortices in a fluid so nearly perfect as air. An air blast in a state of intense agitation from the discharge of a steam jet is obviously much better adapted for rapid diffusion and intermixture with combustible gases than the comparatively quiet streams of air drawn through by the draft. Hence we may be prepared to find that the use of the steam jet is not attended with the reduction of temperature which might at first have been anticipated; but on the contrary its cooling effect is doubtless in many cases more than offset by the more complete combustion of the fuel with a supply of air rather less than that ordinarily used in the grate. This view is apparently confirmed by practical results."

CONDENSATION IN STEAM CYLINDERS.

BY the use of lead facings to pistons and cylinder lids, a considerable economy in the use of steam may be effected. An iron lid and piston will, other things being equal, condense more than three times as much steam as a lead-faced piston and lid. The thickness of metal heated and cooled at each stroke is not considerable, and not far into the metal, a zone of constant temperature, lower than that of the steam, will be found. The distance from this zone to the inside of the cylinder will depend on the conducting power of the metal, and will be about 9 for lead to 12 for iron. It may be shown that, in any case, the thickness of the lead-facing may be kept within very moderate limits. Other materials may be used for the same purpose, as, for instance, tin, the specific heat of which is 0.562, its specific weight being a little less than that of iron. Its conducting power is, however, in excess of that of iron, being as 15 is to 12. Slate or hard pottery-ware might also be employed, but on the whole the balance of advantage appears to lie with lead. (61)

THE AEROPHORE.

THIS is an apparatus for enabling persons to breathe and work, with a light, in unbreathable and explosive gases in mines, wells, sewers, and caverns. It is the invention of Messrs. Denayrouze, of Paris. The aërophore consists of a number of large or small cylinders, as desired, which are lowered into the mine with the workman. Connected with the cylinders is a long flexible tube about an inch in diameter, of such strength that it can not be damaged even by being trod upon. The person who is to use the aërophore first puts on a strongly-made jacket of webbing, to the back of which is attached a couple of moderating valves, which serve to supply the compressed air to the mouth at ordinary atmospheric pressure—not higher—the pipe being attached to these valves. Another pipe passes over the shoulders and to a mouth-piece. The nostrils are closed by a nipper. The mouth-piece is constructed so as to be available either for a light or heavy breathing man. Exhalation is accomplished by means of a small aperture in the tube about two feet from the mouth. This aperture is fitted with a proper valve, which stops the ingress of all air or gases. By another valve and tube, air is supplied to the lamp which the miner carries in his hand, and enables it to burn brightly, and a pair of "goggles" are provided in case the eyes are likely to be affected. These can readily be fastened on by means of an elastic strap.

LIQUID FUELS.

IT is well known that many attempts have been made to use liquid hydrocarbons, such as crude petroleum, tar, and other waste products, as fuels, but usually without success. Captain Dutton thinks that the cost of this fuel will always prevent its economical use, and that the difficulty of burning it adds another objection. He says: "Owing to the very large percentage of hydrogen contained in them, the calorific power is exceedingly great, and when burned under advantageous circumstances the possible temperature is immense. To obtain this high calorific equivalent, it is necessary to produce the most thorough intermixture or diffusion of oxygen with the hydrocarbon gases; otherwise much of the carbon will escape combustion, and it has in all cases been found necessary to volatilize the liquid before admission to the furnace, and even then special precautions must be taken to secure a rapid intermixture of air at the moment of admission. This is best accomplished by means of two sets of gas-jets, one delivering the fuel, the other air, the two currents interlacing, and being injected with considerable velocity."

FUEL IN FURNACES.

M. FOUCAULT, in a report to the Industrial Society at Rheims, combats the idea that the smokelessness of a fire can effect a notable saving in the amount of fuel burnt. He alleges also, on the other hand, that a considerable loss of economy is produced by smoke-consuming apparatus. He brings in support of his opinion the long series of observations made by the Industrial Society of Mulhouse, which have proved that, with the ordinary boiler furnaces, it is only necessary to consume from 125 to 150 cubic feet of air for each pound of coal, while for the most part furnaces pass twice that quantity. If the draft be reduced in quantity much smoke is evolved, but the products of combustion, circulating more slowly, part with their heat more readily to the boiler flues. It is further proved that the best means of reducing the loss of heat by the chimney is by the use of feed heaters in the flue, so as finally to reduce to 200° the products of combustion, which are often discharged as hot as 400°. Feed water heaters, well set, will produce an economy of from eleven to twenty per cent with a reduced draft.

The conclusion is that furnaces with large area and suitable feed heaters are the most economical in all respects. But in order to obtain the best results, much care is needed in stoking. A little at a time and often, should the coal be spread over the front of the fire, and the bright coal pushed back to the bridge. At the same time, the least possible quantity of cold air should be admitted.

THE NEW STEAM-HAMMER AT WOOLWICH.

To say that it is the largest and most powerful in the world conveys but an inadequate idea of its magnitude and might. The weight of the falling portion is within a few pounds of 40 tons, and the force of the falling weight is accelerated many times by the use of steam to drive it down from the top. It is at least four times as powerful as Krupp's hammer. It is estimated that the use of top steam is equal to allowing the hammer to fall of its own weight 80 feet. It has been allowed a striking fall of 15 feet 3 inches, and nobody has yet determined what is the actual force of the blow which it will strike. The hammer is 45 feet in height, and covers, with its supports, a base of about 120 feet square. Above the ground it weighs 500 tons, and the iron in the foundations below weighs 665 tons. It has cost altogether about $250,000, the greater part of which has been paid to Messrs. Nasmyth, Wilson & Co., the patentees and manufacturers.

NEW STEAM AUXILIARY.

A NEW invention by Mr. J. Berger Spence, of London, consists in passing steam at ordinary atmospheric pressure into a solution of caustic soda, which is thereby raised to its own boiling point. It is proposed to use the heat thus developed to generate steam, the waste steam from an engine boiler being employed in the first instance to heat the caustic soda. Mr. Spence showed that the effect was absolutely produced by raising a solution of caustic soda to a heat considerably over 212° by means of a jet of steam, but he stated that he had not yet worked out practical details as to the employment of the idea, though he exhibited a sketch of an arrangement of boilers which he considered might render it available.

BRONZE CASTING UNDER ARTIFICIAL PRESSURE.

A FRENCH officer, Colonel Lavroff, has given his attention to the casting of bronze guns under a more efficient pressure than has hitherto been employed—a parallel operation with that of Sir Joseph Whitworth in the case of iron and steel.

A cast-iron platform is laid on foundation walls; and upon the former rests, first, the ground-plate of the mold, and secondly, the mold itself, which is of great strength. This mold is surrounded by a heavy cast-iron jacket, which is bolted to the platform; springs are arranged to protect the bolts and the other part of the apparatus against the effects of the dilatation of the mold after running. The cover is furnished with a cylinder formed of clay or other bad conductor of heat, and on this is placed a metallic piston with a pocket or receptacle. The piston and pocket form one solid piece, which is supported in its position at the required level by iron bands. The opening for the metal as well as the pocket is lined with fire clay.

The upper part of the metallic mold and the inferior surface of the cover are also lined with fire clay, in order to retard as much as possible the cooling of the upper part of the casting. The air and gases escape from the mold by means of several conical vents. The apparatus producing the pressure consists of a frame formed of two cast-iron cross-pieces, connected together by means of bolts. This frame, while embracing the mold, is at the same time freely suspended to the chain of a crane by means of an iron ring. The frame is furnished on its under side with a piece of metal, which serves to close the opening through which the metal is run, and to transfer the pressure to the piston. This pressure is produced by

means of an hydraulic press fixed to the lower part of the platform, its piston in its descent drawing down the frame.

The conditions laid down by Colonel Lavroff are as follows: First, each transversal section of the interior of the mold should be at least equal to any section above it. Second, the upper part of the casting ought to be preserved as much as possible from loss of heat, by means of a non-conducting lining within the mold. Three, finally, the piston acting on the molten metal should present to it a non-conductor, and, moreover, should act upon the central portion of the liquid column and not over its whole surface.

PRESSURE FORGING.

AT the State Railway Works, Vienna, Austria, two large hydraulic presses are in use, the largest, with a piston 14 inches in diameter, giving 1,500 tons pressure, and the second, with an 18-inch piston, giving 600 tons pressure. The pressure in the pumps is 600 atmospheres. The piston descends upon the work, and for forging ingots it is armed with a hammer-like head. If, for instance, an ingot of soft Bessemer steel, weighing 2,030 pounds, is placed upon the anvil, and the piston brought slowly down, it is crowded into the mass as if it were putty or dough. The piston is then raised, and the ingot is moved forward for a second squeeze, and so on until the first half has been reduced in thickness, when it is turned on edge and the operation repeated. It is then turned end for end, and forged until the whole length has been reduced to the required size. It is cut into masses of the proper length by a chisel forced through the bar by the press. There is no noise or jar in the whole operation, which requires less time than the ordinary method of hammering or rolling, while the pressure affects the very centre of the mass; and there is no distribution of the blow by the vibration of the foundation of the anvil and the surrounding objects, as there is with the violent impact of a steam hammer. The masses cut from the forged ingots are taken to a heating furnace and are made nearly white-hot, preparatory to the operation of pressing. The molds or dies, made in several parts, if necessary, are securely held together by bands of wrought-iron. A plunger head or follower, called the stamp, is attached to the piston and descends into the cavity of the mold. All the parts being properly adjusted, and the inside of the mold and the surface of the plunger being smeared with thick oil, a block of hot steel is thrown into the cavity, the plunger descends and dresses the steel each way into all the angles and recesses of the mold. When the plunger has reached

the proper depth, the piston is raised, and the mold and contents removed from under the press. A few blows of a sledge liberate the forging, which is thrown aside to cool. If the work is well done, all the angles are full and solid. All pieces of the same kind are alike in dimensions, and there is no great excess at any part to be cut away. The rapidity with which intricate forgings are made is one of the greatest advantages of the method. Of such objects as cross-heads for locomotives, twenty-five or thirty can be made in a day. The molds are made of cast-iron, and are used cold. The plungers are generally cast, and duplicates are kept on hand for use in case of breakage. The process is also successfully applied to forming of boiler heads, steam domes, etc., the large plates of Bessemer steel being forced through a ring, while a great number of spokes for locomotive wheels are also manufactured in this way.

The total production of pressed forgings in these works for nine months was 7,830 pieces, weighing 1,071,200 pounds.

CHROME STEEL.

WITH the exception of eighteen pieces, all the metal used in the superstructure of the St. Louis bridge is chrome steel, this alloy being selected by the engineer, Captain Eads, on account of extended experiments thereon showing the highest tenacity under tension and the utmost refractoriness under compression. The steel was made by the Haughlin process, belonging to the Brooklyn Chrome Steel Company, of Brooklyn, N. Y. The following details regarding the metal we find in the St. Louis *Railway Register:*

The quantity of chromium required in the steel is so small, relative to the quantity of iron, that the cost of the alloy is not greater than that of the usual grades of carbon steel. In a pure and crystallized state, it is a grayish, very hard metal, not oxidizable by any acid nor reducible in any furnace.

It is quite probable that the mixture of chromium and iron is truly chemical. As far as can be learned, there is no gathering together into separate crystals, nor congregating in spots, as in the case of carbon; and it would, indeed, appear that, after combination, separation in whole or in part is almost impossible. From this stability of the alloy, it is possible to grade the mixture in exact accord with proportions of ingredients, and to judge of character with much precision.

The most useful property of chrome steel, next to its stability, is the ease with which it may be welded. No

wrought-iron excels it in this; and moreover sand and borax may be entirely dispensed with, since the effects or the heat—for a white heat may be used without fear—afe to glaze the surface with a film of chromium, which, being unoxidizable, presents no obstacle to the full and entire union of the parts. Such springs as those used in vises need, when made of chrome steel, no tempering, but may be put in place direct from the anvil. Watch-springs could, it is believed, be made from it, of extra quality. A ⅛-inch bar can be bent double when perfectly cold with the same certainty as with the best wrought-iron. For anvil and hammer faces, and hammers and mauls, it is peculiarly fitted, because of its homogeneity and the exact equality of hardness over the surface. Blocks of four inches may be drawn out into a crowbar; any welding or upsetting necessary can be done, and the bar finished, with the same facility as though formed of the clearest iron.

As a test of toughness, a bar of chrome steel five-eighths of an inch square has been twisted cold until the angles of the bar lay around a cylinder, resembling a wire cable strand. Seventy turns to the inch made on a cold bar of steel is sufficient evidence of toughness. The results of tests made at the West Point Foundry give for the material an average strength of 180,000 pounds to the square inch. This is considerably in excess of the figures given by authorities as the highest strength of carbon steel, namely, 131,909 pounds per square inch.

THE COMMON HAMMER.

FEW people, says Mr. J. Richards, in witnessing the use of a hammer, or in using one themselves, ever think of it as an engine giving out tons of force, concentrating and applying power by functions which, if performed by other mechanism, would involve trains of gearing, levers, or screws ; and that such mechanism, if employed instead of hammers, must lack that important function of applying force in any direction that the will may direct.

A simple hand hammer is, in the abstract, one of the most intricate of mechanical agents, that is, its action is more difficult to analyze than that of many complex machines involving trains of mechanism ; but our familiarity with hammers makes us overlook this fact, and the hammer has even been denied a place among those mechanical contrivances to which there has been applied the mistaken name of mechanical powers.

Let the reader compare a hammer with a wheel and axle, inclined plane, screw, or lever, as an agent for concentrating and applying power, noting the principles of its action first, and then considering its universal use, and he will

conclude that if there is a mechanical device that comprehends distinct principles, that device is the common hammer; it seems, indeed, to be one of those things provided to meet a human necessity, and without which mechanical industry could not be carried on. In the manipulation of nearly every kind of material, the hammer is continually necessary, in order to exert a force beyond what the hands may do, unaided by mechanism to multiply their force. A carpenter in driving a spike requires a force of from one to two tons, a blacksmith requires a force of from five pounds to five tons to meet the requirements of his work, a stonemason applies a force of from one hunded to one thousand pounds in driving the edge of his tools: chipping, calking, in fact, nearly all mechanical operations, consist more or less in blows, and blows are but the application of an accumulated force expended throughout a limited distance.

Considered as a mechanical agent, the hammer concentrates the power of the arms, and applies it in a manner that meets the requirements of the work. If great force is needed, a long swing and slow blows accomplish tons; if but little force is required, a short swing and rapid blows will serve, the degree of force being not only continually at control, but the direction at which it is applied also. Other mechanism, if used instead of hammers to perform the same duty, would from its nature require to be a complicated machine, and act but in one direction or in one plane.

THE IRON DOME OF THE CAPITOL.

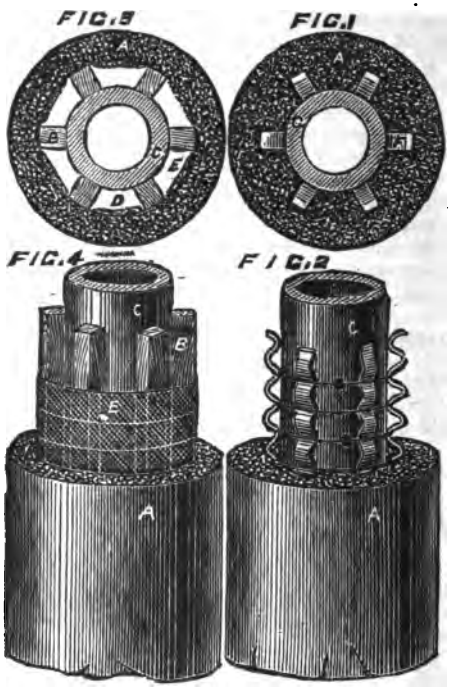
THE iron dome of the Capitol at Washington is 300 feet high, and is surmounted by a metallic statue. In reply to an inquiry as to whether there was a daily movement of the statue, due to the heat of the sun, the architect, Mr. Clark, gives the following particulars:

"The statue on the Capitol has a motion resulting from the unequal expansion of the opposite sides of the dome. The entire length of the line of oscillation of the plummet from the eastern limit to the western limit is only four and a half inches, which would make the inclination in the morning two and a quarter inches to the west, and in the afternoon the same distance to the east. This apportionment of the distance for morning and evening, however, is not strictly correct, and for this reason: that in the morning the east side of the dome is rapidly heated, while the west side is chilled by radiation through the night. Now, as the sun passes to the western side of the dome, this side is heated, but as the east side still retains a good portion of its heat, the expansion is more nearly

equalized on both sides, and the inclination of the statue to the earth to some extent counteracted, so that the inclination to the west is a little greater than that toward the east. The variation is probably about the same all the year round, the extra contracting by cold on one side of the dome during the winter producing the same effect as the extra degree of expansion by heat on the other side in the summer."

IRON AND FIRE-PROOF CONSTRUCTION.

IRON should be used in a building as the bones are used in a human being—to give strength; but it should be protected, as the bones are by the flesh and muscles. A well-known means of protecting iron is that of Messrs. Dennett & Co., of Nottingham, shown in the accompanying



illustrations. In Figs. 1 and 2 the column, C, is first provided at intervals with vertical pieces of corrugated hoop iron, F, which are retained in position, while the concrete

casing is in progress, by horizontal rows of wire binding them to the circumference of the column. The concrete casing is 3½ inches in thickness, and the object of the corrugated hoop iron is evidently to cause it to bend, and to avoid the possibility of a straight joint all around the circumference of the column. In Figs. 3 and 4 the arrangement is somewhat different. In the place of the corrugated hoop iron, fillets of wood, BB, are employed and held in place by a wrapping of iron wire mesh. It will be observed that in this case the thickness of the concrete is reduced to 1¾ inches.

The relative value of these two arrangements will be perceived from the results of the following experiment, which was carried out in Nottingham, and was lately reported in the *Engineer*. Three hollow cast-iron columns were selected, which, for the sake of distinction, may be termed A, B, and C. The two former were similar in dimensions, being about 10 feet in length, and having an external diameter of 7¼ inches. The column, A, was incased with a solid mass of concrete 3½ inches in thickness, as shown in Figs. 1 and 2. The column, B, was incased as shown in Figs. 3 and 4. In both instances the material was fleated on and the face troweled.

The columns, A and B, were fixed erect on the ground, about 4 feet apart, and their caps and bases were entirely inclosed by the concrete.

The column, C, was incased in a manner exactly similar to A, but the concrete was laid thereon only a week before the experiment, whereas A and B had been incased a month previously.

Strips of lead were fixed vertically along the whole length of each column under the concrete and in contact with the iron, it being fairly assumed that, if the lead were prevented by the protection of the incasement from melting, a temperature would be preserved below that which could injuriously affect cast-iron.

A gauge rod, with a self-registering card and pencil, were placed inside each of the columns, A and B, for the purpose of testing the expansion of the iron lengthwise.

All three columns stood within a distance of a few feet from each other, and a fire of wood and shavings, saturated with gas tar, was lighted around their bases, and maintained at as fierce a degree of heat as possible for a space of four and a half hours.

After the fire had been burning about an hour, the hollow incasement of column B showed a crack about three feet in length. This was caused probably by the expansion of heated air or steam within the hollow space, the experi-

menters having inadvertently omitted to form escape holes in the concrete casing, as had been intended. No signs of injury to the incasement of columns A and C were visible, although the flames reached above the caps of the columns.

After two hours had elapsed it was determined to have one of the columns laid horizontally in the middle of the fire, so as to insure a uniformly intense degree of heat along its whole length, as the other columns, when in an upright position, were obviously more severely affected for a few feet above their bases than near their caps. The column C was therefore pushed over so as to lie horizontally in the fire, and remained in that position until the close of the experiment.

The fire was eventually extinguished by a quantity of water thrown on suddenly, and a careful examination showed that no cracking, blowing, or disintegration of the concrete had resulted from this severe test. Portions of the concrete were then removed as speedily as possible from each column. In no case had the strips of lead melted, nor did they show the least sign of injury. The hand could, immediately after the removal of the concrete, be borne on its inner surface, or upon the iron columns, without discomfort; and the registering cards attached to the ends of the gauge rods showed no indication whatever of expansion.

The wood fillet, immediately opposite the crack in the casing of column B, was charred somewhat on its outer edge; the sides and the edge of this fillet next the iron, as well as the two adjacent fillets, were discolored by smoke for two or three feet of their length, and the other fillets remained as white as when they came from the saw. A strip of lead near to the crack in the incasement of column B and another strip in that side of column C which had been laid downwards to the fire, were considered to have suffered the most severe test, but neither of these strips showed indications of melting, and were removed by the hand without inconvenience.

THE DIAMOND DRILL.

THE diamond drill is now extensively used in preliminary mining, to ascertain the exact location and thickness of ore or coal at given points. It is not uncommon to bore into the sides of hills or mountains for hundreds of feet with a 2¼-inch diamond drill of tubular form. By this means solid cores or specimens of the borings can be had. Conglomerate rock cores, 12 feet in length, in one piece, have thus been obtained.

NEW FIRE-PROOF CONSTRUCTION.

A NEW and cheap plan for rendering buildings free from danger of conflagration has been produced in many prominent buildings of Chicago, by Mr. James John, of 457 Wabash avenue, in that city. The mode of application of the invention consists of first nailing rough boards to the under side of the furring, between the wooden joists, and then to fill in even with the furring with coarse hair mortar, gauged with sufficient plaster or cement to make it set. On the mortar, is cemented a row of square boxes, cast also of mortar above which a second row is laid so as to break joints. The boxes are slightly smaller than the spaces in which they are laid, so that the intermediate crevices can be filled up with a liquid concrete. Finally a coarser composition, like the concrete of lime, cement, plaster, etc., with screened ashes of cinders, is packed on top of the boxes to a thickness of one inch. This leaves about half an inch to the top of the strips on the joists to which the floor is nailed. The ceiling of the room beneath the joists is formed by securing sheet-iron strips to the latter, close to the wall, and extending, across and between them, iron wires some two or three inches apart, after which more sheet-iron strips are nailed on to secure the wires to the furring. Over the latter the plastering is laid. The weight of filling and concrete is 20 lbs. to the foot when dry, and it costs about $2.25 per yard. The inventor claims that the joists thus protected can not burn.

IRON COLUMNS.

AT a recent meeting of the members of the London Architectural Association, Mr. Richard Moreland, C.E., read an important paper on "Iron Construction," in which he said that, with regard to cast-iron pillars in long columns, the transverse section had two duties to perform, namely, to support the load and to resist flexure, so that only one-half of the strength of the pillar could be considered available for the resistance to crushing, and the other half for the resistance to flexure. In other words, one-half was in compression and the other half in tension; and this was precisely the condition in which a girder was in; or it might be taken as a question of leverage, the length of one end being the diameter of the pillar, and the other half length of the column; but in the case where the pillar was large in comparison to its length, then the whole of the material must be taken to resist the compression of a considerable portion of its crushing strength. The working load on pillars should not exceed one-tenth to one-sixth of their breaking, and, under ordinary circumstances, should not exceed 25 diameters. Special care

should be taken when the pillar was subject to transverse strains, where heavy goods of unstable form were piled against them, as a considerable strain might be produced from this cause; and also in the event of blows from rolling goods or other causes. Pillars in juxtaposition to brick walls took the whole load when they were strong enough to bear it; but masonry served to stiffen the pillar if secured to it; and if the wall was built in cement, and of considerable thickness in comparison to the iron pillars, they then possibly might assist each other. In cases where the brickwork was liable to be compressed, and the pillar unequal to its load, then obviously nearly the whole weight must be discharged on the pillar: but care must be taken, as possibly intense compression might take place at the base of the pillar. The basis should be as level as possible. Short columns under crushing force were deformed by pyramid wedges forming at the ends and forcing out wedges at the sides; this was also seen in the crushing of stone and other solid materials. For various forms and sections of pillars, and also of different lengths, the strength of the material would vary considerably under the diverse conditions in which it was placed. For small proportions of length to diameter, cast-iron was the strongest material, but its strength diminished, as the proportion of length to diameter increased, faster than wrought-iron; and, in comparison of solid square or wrought-iron pillars with solid round cast-iron pillars beyond twenty-six and a half diameters, wrought-iron was stronger. For ordinary work, no cast-iron columns should exceed twenty-seven diameters. The elasticity of cast-iron was twice as great as that of wrought-iron. The strength of girders to resist resilience was proportional to the weight of the beam, irrespective of the length, so that a beam twice the weight or twice the length would take twice the load to produce the same deflection. Rolled girders were only economical up to a given size and weight.

CONCRETE AS A BUILDING MATERIAL.

IN a paper lately read before the British Association of Gas Managers, by Mr. J. Donglas, of Portsea, upon the subject of making gas tanks of concrete, he presents the following information: At the London Exhibition of 1851 it was found that a beam of pure Portland cement, 14 inches long and 4 inches square, fixed at one end, bore 1,580 lbs. at the other, which is about half the strength of Riga fir. The reduction in strength by mixture with sand was the subject of experiment this year by Mr. Lamb, of New-

castle-on-Tyne, who found the following remarkable results:

	Pure. lbs.	1 cemen and 1 sand. lbs.	1 cement and 2 sand. lbs.	1 cement and 4 sand. lb.
7 days	830	550	375	77
112 days	1,065	859	580	224
Increase per cent	36	55	60	200

The inference he draws from these figures is that, seeing that pure cement at 7 days is ten times the strength of mortar containing one cement and four sand, and at 112 days is only five times the strength, there is good reason to believe the process continues till there is very close approximation. In corroboration of this, Mr. Colson, of the Portsmouth Dockyard Extension Works, who has tested within the last few years about 80,000 tons of cement, has furnished me with the following figures respecting the relative strength of pure cement and one cement to two sand:

	Pure cement. lbs.	Increase per cent	1 cement and 2 sand. lbs.	Increase per cent.
6 months	1,200		246	
12 months	1,400	16.6	404	64.2
3 years	1,600	33 3	1,174	377.2

These are extraordinary results, no doubt, but they are the average of many tests, and most of us will be able to appreciate them when we remember with what difficulty a piece of brick and cement mortar in the above proportions can be broken; frequently the brick gives way before the cement joint. I have at this moment a slab of concrete, 10 feet by 8 feet 6 inches and 12 inches deep, in all 85 square feet, bearing 6 cwt. to the square foot without any appreciable strain. On the other hand, the resistance of Portland cement concrete to compression is greater than that of any of our best building materials. At nine months old, the comparison stands thus, upon a block showing 40 inches of surface:

Portland stone	47 tons.
Fire brick	50 "
York landing	96 "
Portland cement	120 "

Experiments were made by Mr. B. P. Smith, the well-known engineer, for Mr. Hawkshaw, prior to determining the foundation of the Spithead forts; so that, whether for resistance to crushing weight or to tensile strain, Portland cement concrete is stronger than any other ordinary material.

MODERN CAST-IRON.

THE Philadelphia *Trade Journal*, in an editorial on improvement in cast metals, recapitulates the advantages gained by the modern scientific manipulation of cast-iron, in a concise and forcible manner. In the past forty years the gross weight of our cast-iron articles has been diminished fully one-half. Half a century ago the iron frame of a Washington printing-press weighted nearly 1,000 pounds; and although it was an arch of metal 9 inches wide by 3 inches thick, so poor was its quality that it was often broken by the pull of one pressman's arm. Our present smooth, light castings show an actual elasticity under strain which approaches the service of wrought-iron, allowing a large reduction in weight of metal and in the consequent expense.

STRENGTH OF PINE.

PROF. NORTON, of Yale College, states that after repeated strains a molecular change takes place in the wood, and the effect of strain, after an interval of rest, to a great extent not only passes away, but even leaves the stick with less set than it had a short time before. As one of the results obtained, it appears that a load equal to one-fourth of the breaking weight produces a permanent set, and that repeated applications of this load from day to day are attended with a continually increasing set. It results that such wood should never be subjected in any structure to one-fourth of its breaking strain.

SIGNAL FOR GEODESIC OPERATIONS.

M. LAUSSEDAT proposes, for the above purpose, to direct a spy-glass from one station toward a second point, to which the signal is to be transmitted. In the focus of the instrument he places a diaphragm having a very small aperture; so that, on looking through, the field of vision will be restricted to the tower, steeple, or other locality at which the receiver of the signal is stationed. The eye-piece of the telescope is then removed, leaving the diaphragm, and behind the latter is placed, in the axis of the instrument, a light, the conjugate image of which, produced by the conveying glass, falls precisely on the opening of the diaphragm. The luminous ray transmitted through the telescope will fall directly on the edifice comprised on the restricted field of vision, and not elsewhere, and the light is therefore invisible to all without that field. The observer will perceive the objective of the telescope illuminated over all its surface; and necessarily, the larger the diameter of the glass, the farther will the signal be visible.

EQUINE MECHANICS.

FROM recent calculations by H. Fritz, of Zurich, Switzerland, it appears that the useful work performed, per day of ten hours, at speeds of from 2.9 to 9.7 feet per second, for horses attached to agricultural implements, is as follows: Single horse to mower, 27,324,000 foot-pounds; two horses to mower, each, 17,496,000 foot-pounds; same to combined reaper and mower, 23,760,000 foot-pounds; single horse to reaper, without automatic binder, 30,132,000 foot-pounds; two horses to similar implements, 20,979,000 foot-pounds, and finally, two horses to reaper, with automatic binder, 23,960,750 foot-pounds. This, on the average, gives about 23,000,000 foot-pounds to the horse, or some 638 pounds per second. The fact of the animal's gait, it appears, must also be taken into consideration, as, at a walk, the body is supported always by at least two members, while, at a trot or gallop, there is an instant when the horse is suspended in the air, to accomplish which the entire weight must be overcome. M. Sanson, who has also lately carried on some investigations into the subject, says that, in order to gallop or trot, the animal develops an average energy of about 0.1 the weight of its body; while it walks, this is reduced to 0.05. On weighing over a thousand horses, the above author finds that the average weight of animals varying from 4.8 to 5.4 feet in height, is about 1,201.2 pounds. Hence the necessary effort for a horse to displace his own weight, at a walk, is 1,201.2x.05=60.1 lbs.; at a trot, 1,201x.20.1=120.1 lbs. At an average walking speed of 3.2 feet per second, the horse accomplishes, therefore, per day of ten hours, 60.1x115,200=6,923,520 foot-pounds, or, at a trotting speed of 7 feet per second, per day of four hours, 120.1x100,800=22,106,080 foot-pounds. Consequently, to produce a useful labor of 23,000,000 foot pounds, the horse must, when walking, develop a total power of 29,523,520 foot-pounds, and, when trotting, 35,106,680 foot-pounds.

NEW GLAZING FOR POTTERY.

A KIND of lead-glazing is used upon common pottery, the employment of which often causes cases of lead-poisoning among the workmen. M. Constantin, of Brest, France, has recently devised a substitute which is said to be much superior and to possess the hardness and inalterability of glass. He uses silicate of soda, pulverized quartz, chalk, and a small proportion of borax. This glazing may be colored green by copper, and brown or violet by manganese. It is already coming into use in many of the largest French potteries.

THE RIBBON POST.

THE Ribbon Telegraph Post Company, of Manchester, England, have recently introduced a light and graceful form of iron pole or pillar, represented in the annexed engraving. The ribbons are made around a mandrel, which is provided on its exterior with spiral intersecting grooves. The latter form a receptacle for the ribbons, which are wound on by machinery, without twist or strain, and in such a manner that the gradual decrease of the pole is compensated for. The first series is put on from right to left, beginning at the bottom; the next in the reverse direction, commencing at the top. The latter ribbons, of course, overlap, and are, at this stage of the operation, temporarily secured to those beneath them by bolts fitted in holes previously punched in both, so as to coincide exactly at the points of intersection.

The core of the mandrel is then removed, causing it to collapse, when the pole is withdrawn and placed upon a cylindrical bar, ready for the insertion of the angle-irons. These, previously punched, are secured by rivets to the intersections of the ribbons, the temporary fastenings being taken out. The cap, the nature of which depends necessarily upon the uses to which the pole is to be devoted, is then put on; and the base, consisting of various forms, strengthened with extra iron and inserted for some little distance with the ribbon, and secured to a plate which affords a strong support, is added.

The strength of poles thus constructed is said to be very great. Two, without angle-irons, measuring 10 feet by 8 inches, supported a weight of 10 tons without sinkage, deflection, or collapse. The total weight of a telegraph post 31 feet long is about 434 pounds.

On rocky ground, these posts can be fastened directly to the surface of the rock; no lightning-conductor or earth wire is required, since the poles are themselves conductors; no ladders are needed; they offer small resistance

to the wind, and are ornamental and durable. It is suggested that they may be advantageously used as substitutes for the heavy iron pillars or clumsy wooden supports frequently employed in the construction of conservatories, porches, etc. (106)

COMPRESSED AIR MACHINERY.

A PAPER on compressed air machinery, recently read by Mr. William Daniel before the British Institution of Mechanical Engineers, is a valuable contribution to our knowledge of a class of mechanism, regarding which trustworthy information is not abundant. A very complete series of experiments was conducted by the aid of an air compresser having two steam cylinders, each 16x 30 inches, working compressing cylinders of like dimensions, and the whole mounted on a receiver 24 feet long by 5 feet diameter, which formed the bed-plate. After the compressed air was led to a portable engine and there cooled, it was admitted to two cylinders, 10x12 inches, which drove an engine working a friction brake. By means of indicator diagrams, taken from this last-mentioned engine, as well as from both the steam and air cylinders of the compresser, a record was obtained of the losses of power which took place at various stages. From the data a table was completed, the results of which show that, when working with air at 40 lbs. pressure, the usual effect obtained on the brake was only 25½ per cent of the power indicated on the steam cylinders of the air compresser, while with 34 lbs. pressure the efficiency reached 27 per cent; with 28 lbs., 28 per cent was gained; with 24 lbs., 35 per cent, and with 19 lbs., 45½ per cent. The loss of efficiency due to increased pressures may be ascribed to the conditions of the experiment and the increased loss of heat from the air, attendant upon the higher degrees of compression.

Mr. Daniel advocates the use of compressed air machinery for mines, and points out the economy which must result from the fact that, when the motor is idle, there is no loss except the interest of money expended on the machinery, which is much less than that incurred where animal power is employed. He also suggests that the ventilation of the mines would be improved by the discharge from the engines, while the air, being always available in the pipes, could be used to dilute an outflow of gas.

The discussion of Mr. Daniel's paper elicited a number of practical suggestions. Mr. C. W. Siemens pointed out that the development of heat during the compression of air might be avoided by the injection of water into the air-

compressing cylinder, this water taking up the heat as fast as it appeared; while the formation of ice in the engine cylinders might be prevented by similar means, the water in this case giving up heat to the air during the expansion of the latter. Mr. Firth stated that he had got rid of any difficulty with ice by enlarging the exhaust openings. Mr. Brotherhood described his three-cylinder engine, as used for working the Whitehead fish torpedo. This had three cylinders, each 1⅛ inches by 1¼ inches stroke, driven by a pressure of 450 lbs. per square inch, admitted through a reducing-valve from a reservoir of air, stored at 900 lbs. per square inch. This engine had run at 2,225 revolutions per minute, developing 2½ horse-power, or 0.28 horse-power for each pound of its weight. Mr. Cowper suggested that radiating ribs, cast on the cylinders of air compressers or of engines using compressed air, might serve the purpose of facilitating the emission or absorption of heat.

THE NEW DOCK SYSTEM OF NEW-YORK CITY.

At the annual meeting of the American Society of Civil Engineers, Mr. John D. Van Buren stated that the river wall, recommended by General McClellan and adopted by the present department, is composed of *béton* blocks weighing from 25 to 50 tons each, extending from the foundation to within two feet of low water mark, and, above this level, concrete laid in mass, faced with ashlar granite masonry. The idea of using *béton* blocks for this arch is due, he said, entirely to General McClellan, and the late operations of the department show that the plan is an exceedingly expeditious and cheap one. On the Christopher street section, now being built by the department, 14 blocks, weighing about 450 tons, were laid in one day, and 109 blocks, weighing 3,560 tons, were loaded, transported and laid in 18 days of from 10 to 12 hours each. The crew consists of 10 men, including captain and engineer. The total cost of lading, transporting and laying, in 14 feet of water, will not exceed $1.50 per cubic yard. The cost of the blocks, exclusive of the rent of yards, is about $12.50, with cement at $5 per barrel, this material alone costing about $8.50 per cubic yard. It does not cost the city, considering all expenses, over $16 per cubic yard laid. This wall is being built considerably within the estimate made by General McClellan, of $2,500,000 per mile, including the cost of filling.

The departments are now building four large wharves of wood on the Christopher street section of an improved quality, and have nearly completed three of them. Another is built at Canal street, North River. In these

structures they have not found it possible to allow the engineers to introduce any artificial preservatives, except external coatings of fish oil and paint: but in the general character and strength of the woodwork and fastenings, every care has been taken to make them complete and of the very best quality. The pile heads are the only novel features of these piers; they are constructed of built-up columns 20x20 in section and 75 feet length, placed in rows 12½ feet apart, and about 9½ feet apart in rows. The rows are sheathed for low water up to the girders on both sides with 5-inch planking, the ends of which are protected with boiler plates. The heads of the columns are securely passed into the caps and girders. The piles used in the pier, some of which are 94 feet long, are driven in rows 8 feet apart, and 5 feet apart in the row. The square timber is 12x12 in section.

The plan of construction, then, which seems to commend itself as the proper one for the improvement of the water front of New-York, is: To construct a quay wall along the main street of granite masonry, increasing the width of the street considerably, and from the wall to throw out piers of the very best quality of wood, preserved against decay by all possible means, and at once establish a broad main street and have good piers built and taken care of according to a settled plan; and it will shortly follow that all known means of facilitating the handling and transportation of freight will then be introduced by the interested persons, under certain general restrictions.

These public works should go slowly on, say at the rate of half a mile per annum. If in ten years the wall could be completed on the East River and to West 11th street on the North River, its progress would be all that could be desired. The city would then possess the finest dock facilities in the world.

AIR PRESSURE IN WIND INSTRUMENTS.

DR. W. H. STONE, in a paper before the Physical Society of London, describes some experiments on the wind pressure in the human lungs during performance on wind instruments. About 6 feet of water or 13 lbs. pressure per square inch was the ordinary maximum when a small tube was inserted between the lips. When the lips were supported by a capped mouthpiece, as in brass instruments, a much greater pressure could be sustained, and lip muscles invariably gave way long before the expiratory power of the thoracic muscles was exhausted. The following pressures were sufficient to produce an average orchestral tone: The oboe requires an air pressure of

from 5 to 10 ounces per square inch, the clarionet 8 to 14 ounces, bassoon 7 to 14 ounces, horn 2½ to 5 ounces, cornet 5 to 18 ounces, trumpet 7 to 18 ounces, euphonium, 1½ to 23 ounces, bombardone 1½ to 20 ounces.

It will be noticed that the clarionet in this, as in some other respects, differs from its kindred instruments, and also that most of the pressures are small, not exceeding, or indeed attaining, the pressure of a fit of sneezing or of coughing. They are, therefore, very unlikely to injure the lungs, or to produce the emphysema erroneously attributed to them.

THE EDUCATION OF CIVIL ENGINEERS.

THIS was the topic of a recent paper by Mr. Thomas C. Clarke, of Clarke, Reeves & Co., the well-known iron-bridge constructors. Mr. Clark contrasted the English and Continental systems of professional education, and pointed out that the former was mainly practical, while the latter required the student to be thoroughly versed in theory before entering upon actual work. He believed in combining the advantages of both systems, and advocated a thorough training in the natural sciences. Too much time, the speaker said, was now wasted in studying the higher mathematics, which rarely are brought into practical use. The student should be limited to ordinary analysis, and the time thus gained devoted to the study of Nature. After graduating from college, practice in the field should be immediately begun, and then, after an insight had been obtained into the actual labor of the profession, the young engineer might profitably attend a technological school for the purpose of devoting himself to some specialty.

WATER-PROOFING LINEN.

PROFESSOR KUHR gives the following directions for this purpose: Pass the linen first through a bath of one part of sulphate of alumina in ten parts of water, then through a soap bath, of which the soap is prepared by boiling one part of light-colored resin and one of crystallized carbonate of soda with ten parts of water, until the resin is dissolved. The resin soap thus formed is to be separated by the addition of one third of common salt. In the soap bath the resin soap is dissolved, together with one part of soda soap, by boiling it in 30 parts of water. From this bath pass the articles finally through water, then dry, and calender. Made-up articles may be brushed with the solution in successions and be rinsed in the rain. Wooden vessels may be employed.

THE AMERICAN CENTENNIAL EXHIBITION.

ON the 4th of July, 1876, one century will have elapsed since the signing of that immortal declaration which separated the American colonies from Great Britain, and caused the formation of a new and independent nation, the United States of America.

By act of Congress, authority has been given for the holding at Philadelphia, Pa., where the Declaration of Independence was signed, in the name of the United States,

MAIN EXHIBITION BUILDING.

of a grand Industrial Exhibition, by which the growth and resources of the land may be shown, and put in competition with the analogous productions of other countries.

One of our engravings shows the Main Exhibition building, at Philadelphia; the other is a view of the great Art Gallery.

The main or exhibition building is intended to cover

ART GALLERY, INTERNATIONAL EXHIBITION.

over twenty acres, and is located facing Elm avenue, and distant 170 feet, allowing plenty of room for ingress and egress. The building is in the form of a parallelogram,

extending east and west 1,880 feet in length, and north and south 464 feet in width. It will be laterally divided into sections for each nation that may apply for space, the United States occupying 128,000 square feet; the total amount of space in the building being 350,000 square feet, exclusive of the roads and walks. Restaurants will be placed in prominent places in the building. Water will be supplied freely throughout the entire building, the most complete provision being made against fire.

The arrangement of the interior will be such that all nations will be so represented, that while each has its distinct position, yet each class of exhibits can be followed all around the building and examined in detail. In addition to the buildings already named, there will be a Machinery Department, covering at least twelve acres; Agricultural Department, covering eight acres; Horticultural Department, with a spacious Conservatory, and a large number of buildings designed for special purposes. Every accommodation will be supplied for the transportation of visitors by steam and horse cars, arriving under cover in the building, and also for communication over the grounds from one department to another.

In addition to the Exhibition buildings, there will be many others erected on the grounds, to show the process of manufacturing iron, glass, paper, cotton, wool, and other staple articles; also, various foreign nations will contribute special buildings, designed to exhibit the peculiar architectuure of each nation. During the Exhibition there will be a grand international regatta on the river Schuylkill. It is also contemplated to have a grand national encampment of troops in Fairmount Park during the Exhibition.

This structure, which is intended to be one of the affixes to the great Exhibition, is located on a line parallel with and northward of the Main Exhibition building. It is on the most commanding portion of the great Lansdowne Plateau, and looks southward over the city. It is elevated on a terrace six feet above the general level of the plateau—the plateau itself being an eminence 116 feet above the surface of the river. The entire structure is in the modern *rendissance*, massive and graceful in outline, and in consonance with the general Park character. The material is granite, glass and iron. No wood is used in the construction, and the building is thoroughly fire-proof. The structure is 365 feet in length, 210 feet in width, and 95 feet in height over a spacious basement 12 feet in height, the whole surmounted by a dome.

EXTERIOR.—The main front looks southward; it displays

three distinctive features. 1. A main entrance in the centre of the structure, consisting of three colossal arched door-ways, of equal dimensions. 2. A pavilion at each end. 3. Two arcades connecting the pavilions with the centre; central section, 95 feet long, 72 feet high; pavilions, 45 feet long, 60 feet high; arcades, each 90 feet long, 40 feet high. The front or south face of the central section displays a rise of thirteen steps to the entrance, 70 feet wide. The entrance is by three arched doorways, each 40 feet high and 15 feet wide, opening into a hall. Between the arches of the doorways are clusters of columns, terminating in emblematic designs illustrative of science and art.

IMPORTANT BOILER EXPERIMENTS.

A SERIES of experiments has been conducted by the Manchester Steam Users' Association at Mr. Beeley's works, Hyde Junction, with a view of determining by experiments the effect that cutting openings in the shells of cylindrical boilers has upon their strength. Sometimes these openings are introduced at the base of steam domes, and sometimes for carrying downtake flues through the outer shell. In the French or "elephant" boiler, these openings are inherent at the connecting necks, between the lower and upper cylinders. In order, therefore, to test the effect of these openings, even to the bursting point, a full-sized boiler of the Lancashire type, having a diameter of 7 feet in the shell, and 2 feet 9 inches in the furnace tubes, has been constructed and subjected to a series of tests. The first of these tests was made when the boiler had riveted to it a small wrought-iron steam dome, of the same size and strength as many of the connecting necks now in use in the French, or "elephant," and other types of boiler. In preparation for this test, the boiler was very carefully gauged in every direction, and six observers took measurements at various points of its movements, under the gradually-increasing pressure. It was found that the furnace tubes, which were strengthened with flanged joints at each of the ring seams of rivets, were quite immovable, which is satisfactory, inasmuch as their sufficiency for high pressure was impugned at the recent explosion at Blackburn. The ends of the boiler breathed outwards very slightly, and resumed their original position as nearly as may be on the pressure being relieved. The longitudinal seams in the outer shell exhibited no movement. The steam dome or neck, however, burst when the pressure reached 250 pounds on the square inch, showing that it formed the weakest part of the boiler. The boiler was again submitted to hydraulic pressure,

the wrought-iron steam dome having been removed, the opening blanked up, and a cast-iron man-hole of very substantial pattern applied. At a pressure of 200 pounds on the square inch, the cast-iron mouth-piece ripped asunder, the rent extending right across the plate at each side, and into those adjoining. A wrought-iron raised man-hole mouth-piece, with which the boiler was fitted, resisted both tests without the slightest signs of distress, though repeatedly gauged. These tests show how weak those boilers must be in which the man-holes are altogether unguarded, while for high pressure mouth-pieces made of cast-iron must give place to wrought; and also that the openings at the base of steam domes have a decidedly weakening effect, so that they should always be dispensed with wherever it is possible to do so.

SHEARING MACHINERY FOR LARGE PLATES.

MESSRS. EASTONS & ANDERSON have recently made, at their works at Erith, some large shearing machinery of very novel design for the Russian government. Its purpose is to shear the edges of iron plates 40 feet long, 8 feet wide, and of thicknesses up to 1¼ inches, and to divide these long plates by cutting them across when desired. Of course, such monster plates could not be handled in the ordinary way, and accordingly, in the principal machine—that for cutting the longitudinal edges—the plate to be trimmed is mounted on a carriage, which by means of a pitch-chain is traversed past the shearing-head with an intermittent motion. The shearing-head, which is, in fact, a powerful shearing-machine, is mounted on a cross slide situated at the middle of the "run" of the table carrying the plate to be sheared, the arrangement being such that the shears can be set to any desired distance from the centre line of the traversing table, according to the width of the plates to be operated upon. The arrangement for enabling the machine to trim both longitudinal edges of a plate, without removing the latter from the traversing table, is ingenious. When one edge of a plate has been trimmed, the traveling carriage with the plate on it is detached from the pitch-chain, and run on to a turn-table placed at one end of the machine; there it is turned and then run back again to its former position, the second edge of the plate being thus brought under the action of the shears. This arrangement, in addition to its other advantages, insures the parallelism of the two edges. The division of the plates transversely is effected by a second machine, which may be described as a kind of shearing-punch. It consists of a pair of massive standards placed sufficiently wide apart to admit the plate between them,

these standards being connected by a cross girder, on which can be traversed a massive punching-head worked by a cross shaft. The punch carried by this head is of rectangular form, and by making successive strokes in a line across the plate it divides the latter. Both these machines are characterized by the able manner in which they have been designed for their special work, and we hope hereafter to have more to say about them.

PREVENTING INCRUSTATION.

By E. Von Haen, List, near Hanover, Germany.—This process depends simply on the method of freeing the water before it enters the boiler of the substances which cause incrustation, that is, carbonate of lime, sulphate of lime, and sometimes also carbonate of iron. In the waters of Mr. Haen's manufactory, the latter is found so abundant, that the water, after exposure to the air for a short time, takes a strong brown tint.

In order to precipitate the carbonate of lime, lime-water is used, and for the precipitation of the sulphuric acid of the gypsum, chloride of barium. This singular phenomenon is manifested, very important in the proposed method of purification, that the precipitate of sulphate of barytes, which in ordinary circumstances is deposited very slowly, by reason of its extreme tenacity, enveloped as it is by the precipitate of the sulphate of lime which forms simultaneously, is precipitated with this latter. The salt of iron decomposed by the lime-water is also separated, and is deposited in company with the other under the form of sandy flakes, which unite very quickly on the bottom of the reservoir in the state of a compact stratum. The water may be warm or cold.

Filtering is useless, because the precipitate is deposited at the end of a short time—about a quarter of an hour, or even less—so completely that the clear liquid above can be decanted down to a cock placed within a few centimetres of the bottom. It is not even necessary to remove the deposit from the reservoir after each operation, and it can be repeated several times without inconvenience, until, according to the quality of the water, this deposit has accumulated to such an extent as to be in the way.

The water purified in this way contains no longer any traces of carbonate and sulphate of lime, and this is in such condition that it is impossible for it to form incrustations, because, as is very well known, the chloride of lime which the process of purification forms is an extremely soluble and deliquescent salt which does not separate from the water even after long-continued evapora-

tion, and which thus can not give cause to the formation of an incrustation. Further, according to Mr. Von Haen's observations, it would appear that the water which has been freed from calcareous salts that are with difficulty soluble possesses the property of redissolving incrustations already formed; and, in fact, a boiler fed formerly with very hard water, and which was covered with incrustations, when fed some time with water treated by the new process, was cleared of this crust, and presented perfectly clean surfaces.

The expense in all cases is very moderate. At the current price of chloride of barium, about $2.50 per 100 lbs., for water moderately charged with sulphate of lime, say with about 3 grammes of this salt per litre, about 8 lbs. of this salt, costing about 20 cents, is needed for the purification of 100 hectolitres of water.

Among the advantages which this process offers must be reckoned the following: The practical execution of it is easy; its effect is certain; filtering is rendered unnecessary; the formation of incrustation becomes impossible; the cost of the operation is slight; the apparatus, which can be adapted to every arrangement of steam-engine, is simple; fuel is economized; the boilers, and especially the boiler flues, are preserved; and, finally, the stoppages become rare.

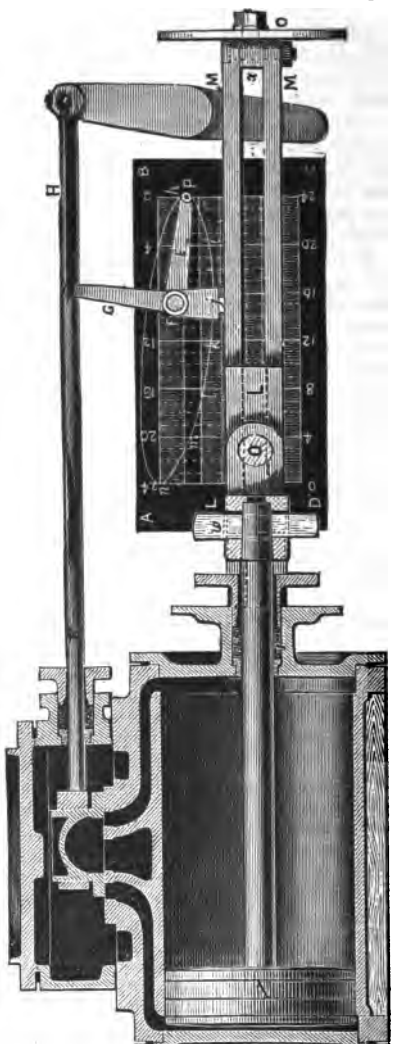
IMPROVEMENT IN GAS RETORTS.

CLAY retorts, when first fired up, are very open and porous, causing considerable loss in the yield of gas; and the same thing happens when they become coated with carbon on the inside and have been recently burned out. If those who use such retorts will, when they are new, coat them (both in and outside) with a solution of silicate of soda, of the consistence of ordinary syrup, the difficulty will be entirely removed. It is hardly necessary to add that the coating should be done before setting, and allowed to dry thoroughly.—*M. L. Jones, Frankfort, Ky.*

THE AMERICAN ARMY GUN.—The new Springfield model of 1873 differs from that of 1870 as follows: The barrel is of low steel instead of iron. The calibre is reduced from $\frac{50}{100}$ inch to $\frac{45}{100}$. The rifling consists of three plain concentric grooves equal in width to the bands, .005″ deep. The rapidity of the twist is increased from one turn in 42 inches, to one turn in 22 inches. There are some other changes as to shape of hammer, screws, band, stock, ramrod, etc. The rear sight has been changed. Instead of the old leaf sight, the Enfield sight with the inclined base is used, which is placed further forward on the barrel.

SLIDE-VALVE INDICATOR AND RECORDER.

OUR engraving shows an instrument employed by M.

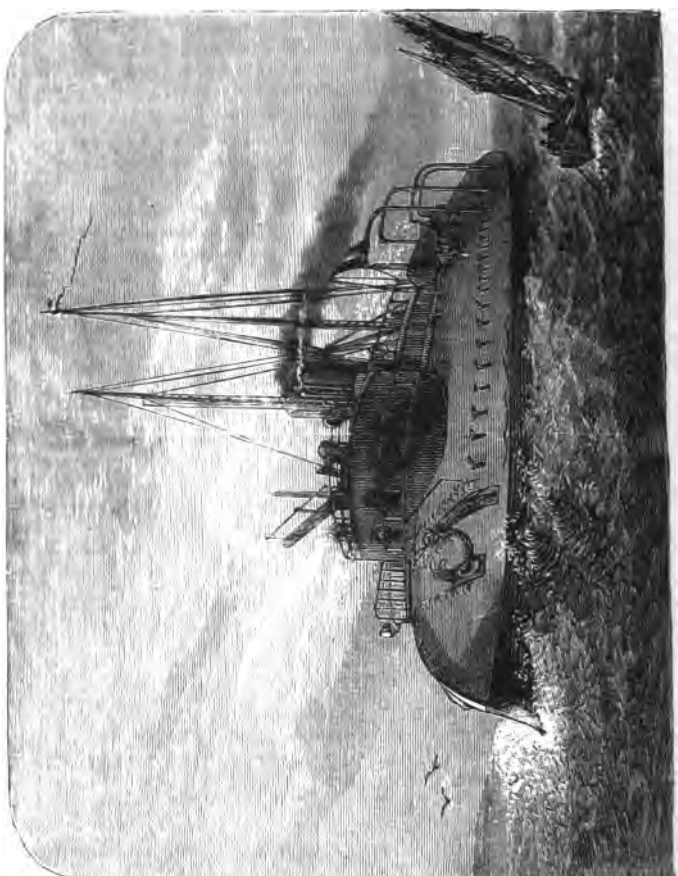


SLIDE-VALVE INDICATOR AND RECORDER.

L. Forney to indicate and record the motion of the slide-valve of a locomotive or other horizontal engine. The principle upon which it works will be understood by supposing that the steam and exhaust-ports be drawn on a board A, B, C, D, placed horizontal, and fastened to the cross-head L, so that it will move backward and forward simultaneously with it and the piston. Let there be a pencil, P, atached to the horizontal arm, E, of a bell-crank, E, F, G. The vertical arm, G, of this bell-crank is connected by a rod, H, to the rocker-pin or valve-stem, so that the horizontal motion of the valve is imparted to the end of the arm G, which produces a corresponding vertical movement of the pencil P at the end of the arm E. This motion is, of course, simultaneous with that of the valve. If this pencil is set so that its point indicates the exact position of the steam edge of the valve, when the piston and board have moved four inches, the pencil will have moved downward and have drawn the portion of the motion-curve from *h* to *i*; and when the piston has moved eight inches the curve will be drawn to *j*, and at 12, 16, 20 and 24 inches of the stroke the curve will be drawn to *k*, *l*, *m*, and *n*. During the return stroke a corresponding curve, *n*, *o*, *h*, will, of course, be drawn. With such an instrument, curves can, of course, be drawn for any position of the link, and they will show the exact movement of the valve during the whole stroke, and will indicate all the defects resulting from bad proportions or misconstruction, lost motion in the parts, or other causes of error or irregularity.

In using this instrument, however, it is impracticable to attach a board to the inside of the cross-head, and it is therefore fastened to the outside. The horizontal arm E is made of thin steel, so as to form a spring. The end has a small *boss*, with a hole in it $\frac{3}{16}$ of an inch in diameter. This hole has a screw thread cut in it, into which an ordinary hard drawing-pencil is screwed. The spring is so arranged that the pencil will not be in contact with the board, unless it be pressed against it. The locomotive is then placed on a smooth piece of track with steam on and run very slowly, so that a person walking alongside can press the pencil against the surface of the board, which should be covered with drawing-paper. By watching the cross-head when it reaches the end of the stroke, the pencil can then be pressed against the paper and kept in contact through the whole stroke, and instantly released when the motion-curve is completed. The link can then be placed in another position, and any number of curves be drawn, which will furnish the most accurate means of analyzing the motion of the valve. (27)

THE FRENCH IRON-CLAD, "LE TIGRE."



THE NEW FRENCH IRON-CLAD AND TURRETED STEAMER, "LE TIGRE."

THIS enormous engine of war was constructed for harbor defense. It is, in fact, a floating fort, a ram, and a torpedo boat, possesses good sailing qualities, and will prove a most efficient protection in case of a naval bombardment of any of the French seaports.

The ship is provided with an armored turret, carrying the heaviest guns, turtle-shaped deck to deflect shot, while her bow is provided with a ram, intended to sink the strongest vessel with which it comes in contact.

GUNPOWDER EXPERIMENTS.

CAPTAIN NOBLE AND MR. ABEL have come to a definite stage with their experimental researches into the action of fired gunpowder, and have embodied their conclusions in a report of the Proceedings of the Royal Society.

Their objects they state to have been: (1) To ascertain the products of explosion when fired in guns and mines; (2) to investigate the tension; (3) the effect of various sizes of grain; (4) the variation caused by various conditions of pressure, comparing explosion in a closed vessel with that in the bore of a gun; (5) the volume of permanent gas; (6) the heat; (7) to ascertain the work performed on a shot in the bore of a gun. For this very careful experiments were carried out to ascertain the pressure, volume of permanent gas, heat, and analysis of gases and solid products. A vessel of mild steel, tempered in oil, was used, completely closed with a closely-fitting screw firing plug, through which were led circuit wires with fine platinum wire inclosed with mealed powder, which it fired when heated by the current of a Daniell battery.

The results were briefly as follows: The pressure was registered by Captain Noble's crusher gauges at from 1 ton to 36 tons per square inch. The analysis of the gaseous products showed a regular change, due to variation in pressure, carbonic anhydride increasing, with a decrease in carbonic oxide, as the pressure increased. The solid products were subject to greater and less regular variation; speaking generally, the chemical action is more complicated than has been supposed, and the old fundamental equations are found to represent it very imperfectly. More carbonic oxide and potassium carbonate, and less potassium sulphate than has been thought, is produced. Potassium sulphide is thought to be formed primarily, but eventually it is not present in any considerable quantity, having given place to potassium hyposulphite. The temperature of explosion is found by means of platinum wire or foil to be about 2,200° Cent. About 35 per cent of the heat generated is communicated to a small arm, and but 3 per cent to an 18-ton gun. The products of explosion consist of about fifty-seven parts by weight of solid to forty-three of permanent gas. When the powder fills the space in which it is fired the pressure is about 6,400 atmospheres, or 42 tons per square inch. The pro-

ducts of explosion generally are the same in a gun and in a completely closed vessel. The work on the projectile is due to the elastic pressure of the permanent gases. These results have only been obtained by a long and laborious course of very carefully conducted experiments. They are very valuable, and such as but very few individuals have the means of carrying out. (28)

THE MOST REMARKABLE RAILWAY IN THE WORLD.

THE Callao, Lima, and Oroyo Railroad has no equal in the world for skillful engineering and cost of construction. Mr. Henry J. Schenck, engineer on the work, in a recent letter from Lima, Peru, gives the following particulars:

The commencing point is at the city of Callao, on the coast of Peru, whence it runs north and east, and terminates at the town of Oroyo, on the east side of the Andes mountains, there making close connection with the head waters of the Amazon river, thereby making speedy conveyance and cheap transportation for commerce and the traveling public across the continent of South America, and avoiding the long and perilous trip around Cape Horn. This gigantic project of scaling the mighty Andes by rail was first projected and is now being carried out by Henry Meiggs, the railroad king of South America, tunneling mountains of solid granite and spanning streams and passes at heights from 35 to 252 feet above their beds, almost irrespective of cost. Some idea may be formed of the cost of construction where operations were commenced on a level with the sea, and in a distance of 104⅓ miles the bed of the road has attained the unparalleled height of 15,645 feet above the level of the sea, and in that distance passing through 58 tunnels measuring from 200 feet to 3,737 feet in length. The entire length of the road is only 136 miles, but it cost $37,350,000 in American gold coin.

A second great reason for the enormous cost of constructing roads in this country is the scarcity of material, all of which is brought here from the United States. The first bridge of importance is that which spans the Agua de Verruga. The central pier of three that support this grand piece of superstructure is 252 feet in height, resting on solid masonry 70 feet square, and spanning a space of 575 feet. Proceeding over a perilous portion of the road, winding around spurs of mountains, through long tunnels, some of which are arched only by their mother-rock, others more artistically faced by first-class masonry, the bed of the road forming long and rounding turns, so that

at times there may be seen three lines of rails, lying one above the other.

At this place also, which is situated between two thriving little towns, called Surco and Matucana, may be seen the same mountain tunneled twice, one tunnel being directly above the other, at a distance of 90 or 100 feet. Passing this romantic place, still ascending a grade of 105 to 211 feet to the mile for a distance of 23 miles, and we reach that picturesque spot called in Spanish "La Infernilla," meaning in our language "The Gates of Hell," a place where nature has formed an opening through the mountain, through which passes the swift waters of the river Rimac, walled up by solid rock to a height of over 2,000 feet above the bed of the river, presenting a face as smooth as if cut so by the hands of skilled workmen. Here may be seen a display of masterly engineering, in order to overcome this colossal obstruction. In many other places, where the maximum grade brings the bed of the road to a point utterly impassable, an opportunity always presents itself for an outlet by forming a V and retracing the already passed over portion of road alongside of the mountain until an elevation is obtained whereby a pass may be effected. But at La Infernilla no such opportunity presents itself; consequently, there was no alternative but to tunnel the mountains of volcanic rock, or abandon the projected route. The work was at once commenced on the south side of the river, and in order to push it more rapidly an entrance was commenced on the river side, which was done only by letting men down from the tops of the smooth-faced walls by ropes, thereby supporting themselves until they drilled and blasted a foot-hold and entrance. This done, the work proceeded rapidly, with the aid of the celebrated diamond drill. And on the opposite side of the river a repetition of the same labor was soon commenced. The tunnels being completed, the fearful chasm was soon spanned by a magnificent iron bridge. It connects the two tunnels, viz., Nos. 31 and 32, at a height of 200 feet above the bed of the river, with either end resting on natural masonry.

Again, on emerging from the opposite side of the tunnel No. 32, another great obstacle presents itself. On the entrance of the same tunnel the bed of the river is 200 feet below that of the road, and only a few yards from the outlet of the same tunnel the road-bed falls several feet below the river; thus an idea may be formed of the tremendous fall, and with what rapidity the waters of the Rimac force their way through these mountain passes. In order to overcome this great obstacle, a tunnel is now being built

large enough for a double team and carriage to be driven through, in which 500 barrels of powder will be fired at a single blast, for the purpose of blowing down the mountain, thereby making a new bed for the river to pass, and leaving the old bed with a small amount of excavation ready for the bed of the road. One other blast of 1,000 barrels of powder was used, creating a sensation similar to that of an earthquake for many miles around its vicinity. Here we leave La Infernilla, that stupendous work of nature, utilized and still more beautified by art, and wend our way through already completed tunnels, over mountains, and through river valleys, until we at last reach the summit of the Andes at a place called Gallera, the highest point of the road, viz., 15,645 feet above the sea. This altitude is the bed of the road, not to speak of the many hundred feet of rock still towering above the tunnel through which pass the iron rails.

Doubtless a great many people living in North America are under the impression that there is little or no snow in this part of the globe, but such is not the case, as at this altitude we have perpetual snow. At this point the longest tunnel on the road is being built, being 1,150 metres, or 3,737 feet (English) in length, which has been under course of construction for about twenty-six months. We expect to complete it in 1875, when the entire line will be ready for the rails. The greatest obstacle which the laborers have to contend with is the rarity of the atmosphere, the pressure being only eight pounds to the square inch. The state of affairs is endured only by men of iron constitutions, so to speak. With the aid of the diamond drill, which considerably lightens the work, we hope soon to see the tunnel ready for the rails.

From this point commences a gradual descent down the east side of the Andes mountains to the town of Oroyo. The work here being comparatively light, is already completed. From Oroyo other important lines of road are soon to be built, thereby opening up one of the richest and most fertile countries of the globe—a country heretofore without an outlet, except by mule-back.

SMALL ENGINE.

I HAVE noticed an article in the *Scientific American*, requesting a statement of the performances of small engines. A few years ago I built a small engine, which I set up in the *Herald* office in this place. The dimensions of the engine were as follows: Cylinder, 2 inches by 4 inches; steam ports, $\frac{3}{16}$ inch by 1 inch, and exhaust $\frac{1}{4}$ inch by 1 inch; outside lap of valve was $\frac{1}{16}$ inch; no inside lap; throw of valve was $\frac{1}{4}$ inch. The engine

also had a link, the slot of which was 2 inches long. The main rod was 8 inches from centre to centre. The pin in the cross-head was ⅝ inch in diameter, and the bearing of the main rod on crank was ¾ inch in diameter. The entire length of the bed plate was 2 inches. The shell of the boiler was ¼ inch thick, and the heads ⅜. The boiler was 3 feet long by 1 foot in diameter, with nine 1¼-inch flues. Half of the boiler and the flues made up the heating surface. The grate was 1 foot square. The flame went under the boiler, and returned through the flues to the stack. The pulley on the engine shaft was 6 inches in diameter, over which a belt ran to a 16-inch pulley on a fly-wheel of 700 lbs. This wheel was belted to a line of 1¼-inch-shafting, from which a large Potter newspaper press was run. The pulleys were of equal diameter from the fly-wheel to the press. With 75 lbs. of steam, the engine, making 300 revolutions per minute, ran the Potter press, printing 1,000 sheets per hour; also a medium-sized press, printing 1,200 sheets per hour. A small armful of wood and four bucketsfull of water was sufficient to run off the edition of 1,200 copies in a little over an hour. The water was pumped cold from a tank by a half-stroke pump directly into the boiler. The exhaust steam was turned into the stack. Has the performance of this engine been beaten by any similar small engine? The edition was formerly worked off by four men, turning the large wheel by cranks, in four hours.—*Frank C. Smith, Delaware, O.*

(83)

SPRING-PROPELLED CARS.

In application to the ordinary form of street-car, a portion of the space below the floor of the car is utilized for an arrangement of a series of drums or barrels, containing the springs, which may be arranged transversely in two groups or sets, suitably inter-connected, so as to form one continuous volute, acting to generate evolution of the driving-wheels, and thus effect propulsion of the car. At the terminal, or other intermediate stopping-stations, the means of winding up and recoiling the springs, by any suitable fixed steam-engine or other prime-motor, are to be provided, rotary motion being communicated by shafts under the roadway to vertical spindles and geared wheels, which, being thrown into temporary connection, for the purpose, with the spring-barrels, will coil the springs until the requisite tension-power is obtained. An arrangement of clutches is interposed between the spring-barrels and the driving-wheels, whereby the uncoiling motion of the springs, which is constant in one direction only, may be transformed into an ultimate variable rotary motion, giv-

en out in opposite directions as needed, for reversing the direction of propulsion of the car.

The accompanying engravings represent an ordinary tramway-car in elevation, fitted up with this self-propelling appliance, and showing the mechanism for winding up the coiled springs applied thereto.

Fixed horizontally and transversely beneath the carriage flooring, and situated at about the centre of its length, are two series or groups of hollow drums or spring barrels, fitted on to sleeve shafts, carried on fixed axles; in each group there are five barrels, but any less or greater number of barrels may be employed, as may be

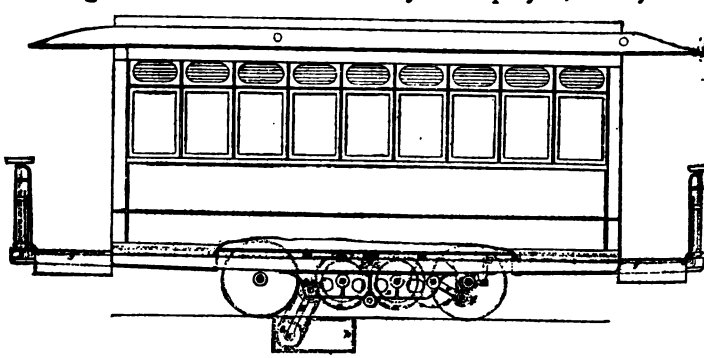


FIG. 1.—STREET-CAR WITH SPRING MOTIVE POWER.

convenient and requisite. Simultaneous operation of all the springs in both groups may be secured and maintained; or, on the other hand, action may be limited to the springs of one series only; the arrangement and details being as follows.

The winding up of the spring barrels is effected, as explained, by engine power, located at suitable intervals along the track, as may be convenient for the run, or at special stopping-places. In Fig. 2 the stationary engine, I, and fly-wheel, K, drives by belt the pulley, L, fixed on horizontal shaft, M, carried in bearings, inclosed in a metallic tube or casing, beneath the roadway, and extending across the tramway track, close alongside whereof a covered box, N, is sunk in the roadway, inclosing a chain-wheel, O, affixed on the shaft, N. The endless pitch-chain, P, passes round O, and a second chain-wheel, Q, carried on a pair of radius arms, R, supported on M. The axle of Q is fitted with a sleeve so shaped as to connect with the winding-axle, C, of the tramway-car, and thus

give the requisite motion thereto. On the arrival of a car at any station requiring to have its spring-tension renewed, the chain-wheel Q is raised into position, connected with the shaft, C, and the spring barrels are wound up by

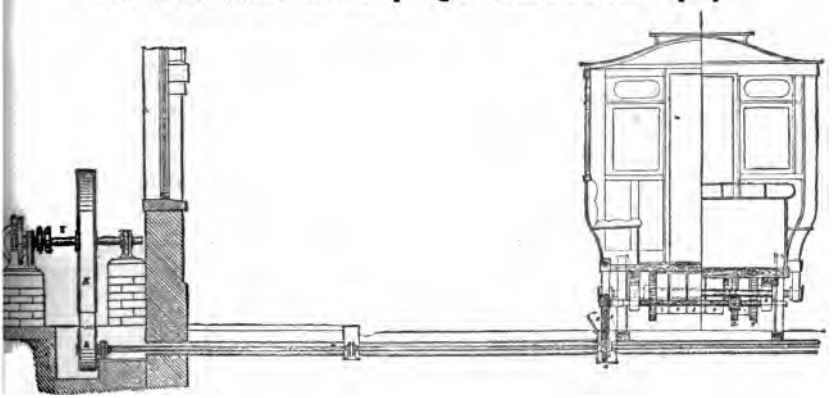


FIG. 2.—WINDING UP THE CAR SPRINGS.

the engine, which being done, Q is disconnected, and depressed into its original position.

It has been computed that the actual tractive force requisite to overcome the resistance of a tramway-car weighing 5 tons gross, is 60 lbs. on the driving-wheels, corresponding to 720 lbs. on the periphery of the spring barrel; 24 lbs. and 288 lbs. respectively correspond to a gross weight of 2 tons; and in like proportion for intermediate weights. So far as previous experience goes, a spring 6 lbs. in weight, exerting a direct pressure of 105 lbs., may be taken to represent the maximum in size and power of such steel springs. Under the stimulus applied by M. Leveaux's researches, the steel manufactures of Sheffield, by special and improved plant, annealing ovens and appliances, have turned out springs 50 to 60 feet long, capable when duly coiled of exerting a pressure of 800 lbs. to 900 lbs. without permanent set; in France also, steel driving bands, with great elasticity, are made 100 yards in length, so that the question of the possibility of obtaining springs of the requisite size and power is practically solved.

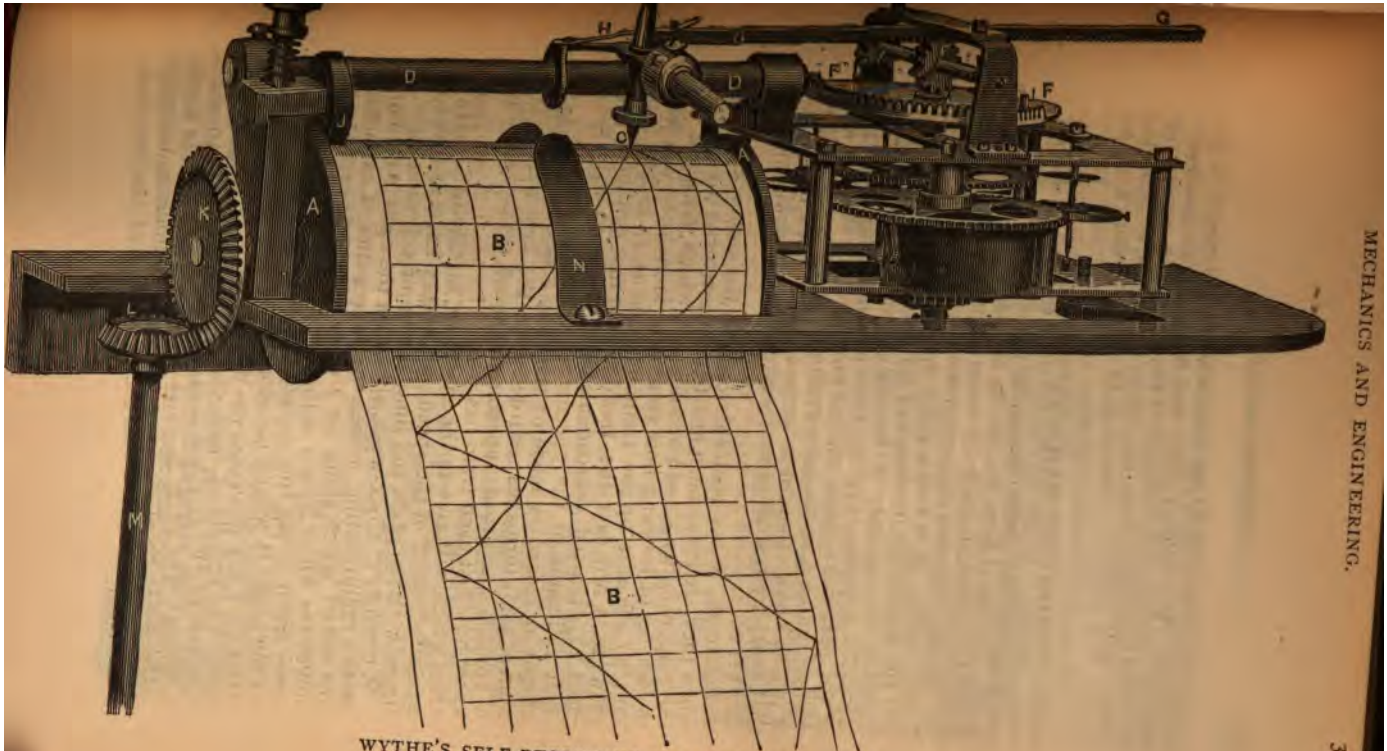
Having satisfactorily tested the principle in a working model, to one-sixth scale, on a small temporary tramway of considerable length, M. Leveaux has had all the necessary mechanism and appliances made by a well-known firm

of engineers, so as to fit up a tramway-car or cars, for actual travel upon some of the lines of metropolitan tramways in London; for which, indeed, the arrangements are now nearly complete, so that the practical working of the system will speedily receive a thorough public demonstration. (106)

SELF-RECORDING RAILWAY SPEED-INDICATOR

THE instrument here illustrated is the invention of Mr. W. W. Wythe, of Erie, Pa., and is intended to indicate and record the speed of a railroad train during the whole period of its trip, and it is therefore especially useful on freight trains. It is well known by every railroad officer that the employees in charge of trains often run without regard to the interests of the road in this respect, in many instances stopping between stations on trifling pretexts or for personal objects, and making up their time by excessive running, to the very great detriment of the road. It is also known that, in defiance of the laws that demand that every train shall come to a stop at the crossing of another road, there are many instances where this rule is disregarded. When accidents occur from such causes, or when they are incurred, it is often difficult to prove where the responsibility should be laid. The difficulty has been in *knowing* or learning how fast trains are run. Even if a railroad officer is on the train itself, he can do no more than guess how fast the train is running, and even the most experienced railroad men will differ very widely in their estimates of the speeds of trains. If, however, a graphical record is made of the rate of speed at which a train runs, it furnishes recorded evidence of the fact, and it enables a railroad superintendent or other officer to know how fast each train has run. The uses of an apparatus which will give to the officers of a railroad company a faithful record of the speed attained by its trains at all times, with the place and time of stopping, is obvious.

It consists of clock-work, shown on the right, which imparts a reciprocating movement to a pencil, C, attached to a slide I, which slides on the rod D. The cross-head moves the whole length of this rod and back again in one hour, and in doing this the pencil will trace a straight line on the paper B, wound round a drum, A A, provided the latter does not revolve, as is the case when a train stands still. The spindle or shaft of the drum has, however, a bevel wheel, K, attached to it, into which a bevel pinion, L, gears. The shaft M of this pinion is connected with gearing on one of the axles of the car, which causes the drum A A to revolve with the movement of the car, fast



WYTHE'S SELF-RECORDING RAILWAY SPEED-INDICATOR.

when the car runs fast, and slower when the speed is diminished. The strip of paper B B is ruled with longitudinal lines representing minutes of time, and with transverse lines representing distance—that is, miles or quarter miles. The paper has also printed on it the names of the stations at such distances as they occur according to the scale. In some cases the grades and curves are also printed on the slip. It will be readily seen that when the paper is at rest the pencil, driven by the clock, will draw a straight line across the paper, the length of the stop being indicated by the number of minute spaces drawn, while the varying speeds of the train will be shown by a diagonal line which varies from the perpendicular according as the speed increases, which can be readily ascertained by counting the number of spaces which cross a mile run. At the end of every half hour the pencil changes its direction by the mechanism alluded to, so that the diagonal line produced will be something like a zig-zag, or continuous letter W, with occasional perpendicular lines or curves that indicate the stoppage, switching or backing of the train.

The paper is put upon the roller at the commencement of the trip and remains until the train returns (or longer, if desired), as it makes no difference which direction the car is running. The whole apparatus is inclosed in a neat box (not shown in the engraving) about 12 inches long and 4 inches high, and is locked up, so that neither the instrument nor its indications can be tampered with, or in any way altered.

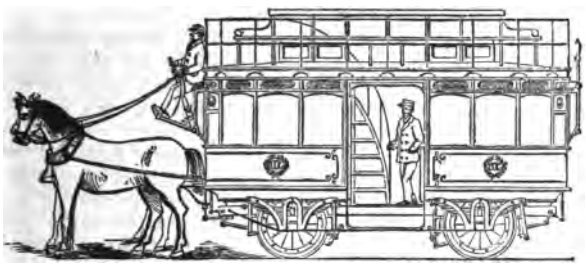
This apparatus has been practically tested on a number of Western railroads, and develops the fact that nearly every freight train makes excessive speed, contrary to time-table instructions.

SIR WILLIAM THOMSON'S ECLIPSING LIGHT.

THE Belfast Harbor Commissioners have adopted Sir William Thomson's beautiful system of eclipsing light, in connection with their lighthouse on the Holywood Bank, in the Belfast Lough. The new apparatus is exquisitely finished, and consists of a train of wheels carrying the necessary screens for eclipsing the lights. It may be stated briefly, that three screens are carried round the light once in about eleven seconds. Two of these are narrow, while a third has twice the breadth; the result of which is to give two short eclipses and one long eclipse. The screens are arranged together in such a way as to afford two short eclipses and one long one, or, in other words, *dot, dot, dash,* in accordance with the Morse telegraph alphabet.

NEW STREET RAILWAY CAR.

THE car at present in use in London is constructed to carry forty-six passengers. It has a total length of 25 feet over the ladders; of this 9 feet are occupied by the plat-



NEW STREET RAILWAY CAR.

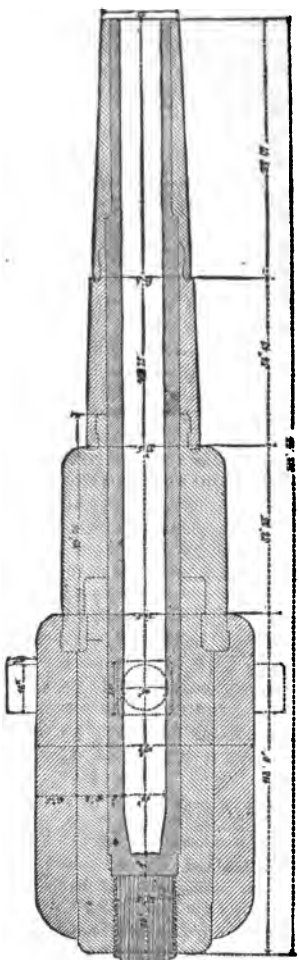
forms and steps. This length is objectionable, as it involves a large amount of useless dead weight. The brake also, being applied from the end of the platform, tends to depress the ends of the car, so that the cill of the car has a considerable camber. The weight of an empty car is 2 tons 15 cwt., and that of a car carrying thirty passengers 2 tons 4 cwt. The improved car shown herewith presents a reduction in length and weight for the same number of passengers, and the rounded ends, whereby overhanging is prevented and passenger accommodation improved. The central platform adds to the stability of the roof and framing, and the staircase affords easy access to the roof. An elevated seat is adopted, which gives the driver a greater range of rein and greater facility for handling the horses. The brake gear is arranged so that both sides of the wheels are gripped, thus equalizing the action and preventing undue strain on the adjacent parts. The weight of one of these cars, built to carry fifty persons, is 2 tons 6 cwt., and the length 20 feet. Those built to carry 32 passengers weigh 1 ton 16 cwt., and have a length of 15 feet 6 inches.

FUSION OF PLATINUM.

THE fusion of platinum has been effected by N. Violette. Partly in fragments and partly in a state of sponge, it was placed in a Hessian crucible lined with plumbago, and subjected for one hour to the heat of the furnace. A perfectly fused button of platinum, of the same weight as that of the metal introduced, was found at the bottom of the crucible.

THE NEW EIGHTY-ONE-TON GUN.

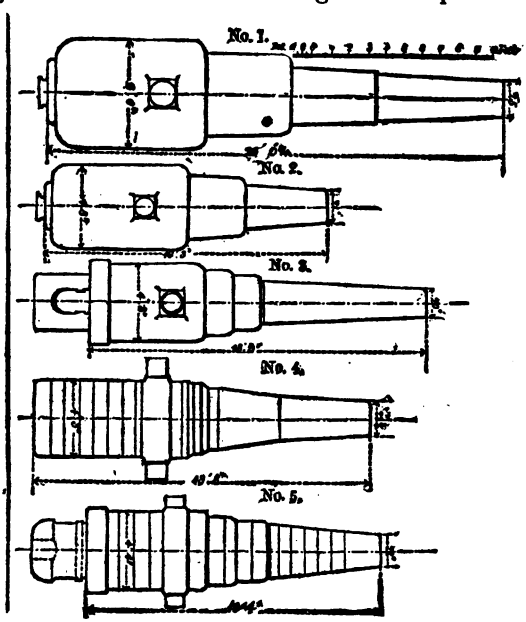
ONE of the most remarkable productions in wrought-iron of modern times—having regard to the weight of metal in the several parts—is now being slowly brought into shape in the Royal Gun Factories, Woolwich Arsenal. This is the latest development of the Fraser, or Woolwich type of gun, which will weigh no less than 81 tons. This gun, which, when finished, will be the largest wrought-iron gun in the world, is constructed on the same principle as the 35-ton gun and others of the same class, the various coils being similarly disposed around the steel tube. Although the 81-ton gun may, in some respects, be considered as an experimental weapon, there is every reason to believe that on trial it will prove a practical success.



NEW 81-TON GUN.—CHARGE 300 LBS. POWDER—PROJECTILE 1,650 LBS.—RANGE 7 MILES.

The 81-ton gun, when completed, will consist of an inner tube of Firth's steel, weighing 16½ tons as a forging, and measuring 24 feet 7 inches in length and 5 inches in thickness, except at the breech end, where it is greater, and the muzzle, where it is less. It will have a bore 24 feet in length, and a primary calibre of 14 inches. This calibre will ultimately be increased to 16 inches, but the gun will first undergo a series of trials with the 14-inch bore. It will then be bored out to 15 inches; will be again experimented with, and subsequently bored out to the final calibre of 16 inches,

thus giving the steel tube a mean thickness of 4 inches. The particular description of rifling has not yet been determined upon, but there will probably be 12 grooves .2 inch deep and 1.5 inches wide, with an increasing twist. The cascabel is of steel 26 inches long, and 20½ inches diameter, and will be screwed into the inner coil close home to the tube. Outside the breech end of the steel, and extending along it for a length of 133.25 inches toward the muzzle (inclusive of the cascabel), will be shrunk on the inner coil, which is 10.5 inches thick and will weigh about 30 tons. This coil has been made from a single thickness of bar, the transverse section of which was 12 inches deep by 10 inches wide. Outside this coil will be shrunk on the outer or trunnion coil, which weighs over 50 tons as a forging. It is 13.5 inches thick, and will bring the outside diameter of the gun at this part to 6 feet.



COMPARATIVE DIAGRAMS OF RECENT GREAT GUNS.

At the point where the trunnion coil ends on the outside of the gun the diameter is reduced to 54.5 inches. Here commences, on the outside, another coil known as the 1st

coil ; this coil, however, extends backward for 13 inches under the trunnion coil, and for 25 inches over the inner coil. This 1st coil is slightly tapered, and has a maximum thickness of 15 inches. At the point where it finishes on the exterior, the diameter of the gun is further reduced to 37.5 inches. From that point the fourth coil extends forward for an external distance of 56.43 inches, when the outside diameter becomes reduced to 32.3 inches. The fourth coil is slightly under and overlaps the 1st coil, and is overlapped by the fifth or muzzle coil, which extends forward 87.07 inches, and has at the junction point a thickness of 5.32 inches tapering to 2.5 inches at the muzzle. At this latter point the outer diameter of the gun is 25 inches, the bore being 14 inches, the steel tube 2.75 inches × 2 = 5.50 inches, and the wrought-iron coil 2.75 inches × 2 = 5.50 inches; total, 25.0 inches. The length over all is 26 feet 9 inches.

The gun is thus composed of seven pieces, namely, five wrought-iron coils, the steel tube, and the cascabel. To produce the weapon many alterations have been made in the plant and machinery at the royal gun factories, and several new tools and special appliances have had to be devised. Thus the coils are welded on end in a reverberatory furnace having a cubical capacity of nearly 2,000 feet. The bar of which the trunnion coil is composed was about 200 feet in length, and involved a special arrangement of the reheating furnaces. The hot oil-bath and furnace, in which the tempering of the steel tube is effected, is now being deepened and otherwise altered to suit the proportions of the new gun, and a new deep pit has been prepared for the purpose of shrinking the various parts of the gun together. This operation being performed with the gun on end, the tallest crane in the department is not high enough, so that the pit has had to be sunk some 20 feet below the surface to enable the shrinking operations to be performed. A pair of tongs for handling the breech coils have just been completed which weigh about 25 tons and are 60 feet in length. With all these special appliances, the cost of the gun will be greatly in excess of what it would be if it was one of a number, but in the end it is anticipated that guns of this size may be produced for about £6,000 each.

The 81-ton gun, it is expected, will be finished about June, 1875, and it will then undergo the usual course of trial at Shoeburyness. It will burn 300 lbs. of powder behind a projectile weighing 1,650 lbs. ; its expected range will be 7 miles, and its duty that equal to penetrating a 24-inch armor plate at a range of a mile. The gun is in-

tended to form part of the armament of the "Inflexible," her other guns being of the same size, or possibly even larger.

In connection with this subject, we publish diagrams showing the outlines of the 81-ton gun and 35-ton gun, the Kiupp 30½-centimetre (12 in.), and the Russian 40-ton breech-loaders (Broadwell system), and the French 32-centimetre (12.59 inch) gun. The following table gives some particulars of the weights, charges, etc., of each:

Number in Diagram.	Service.	Calibre.	Weight.	Powder Charge.	Weight of Projectile.	Total Energy of Projectile in Foot-Tons.	Muzzle Velocity.
No.		in.	tns.	lb.	lb.		ft.
1	Woolwich....	14	81	300	1650	..	..
2	"	12	35	110	700	8200	1300
3	Prussian.....	12	35.4	110	565.5	8970	1508
4	French.....	12.6	34.5	136.69	760.5	9077	1312
5	Russian.....	12	40	113.8	..	..	1398

The reputed high velocity of the 30½-centimetre Prussian gun is, we think, open to some doubt, but if correct, it will be seen that the total energy of the projectile from this gun exceeds considerably that of the English 12-inch gun, and is almost equal to the French 32-centimetre, with its remarkably high powder charge and heavy projectile. (28)

CURIOUS PROPERTIES OF PALLADIUM.

JAMES DEWAR has ascertained that a thin slip of palladium, fixed at one end and properly placed in a hydrogen flame, may be made to vibrate and produce musical sounds; the effect is due to the absorption of the gas causing an increase of volume in the metal, by which it is moved into a hot part of the flame where its hydrogen is expelled, and its own elasticity then brings it back, so that one side is again exposed to the cool gas in the inner part of the flame.

ARTIFICIAL CEMENT.—Carriere prepares an excellent cement at a low price, by strongly heating in special furnaces a mixture of highly argillaceous limestone and hydraulic lime. (22)

POCKET DISTANCE-INDICATOR.

THIS little instrument, made in Paris, is carried in the waistcoat pocket or in the fob, or else attached to a belt or to a button; the hook attached to the ring must be so fastened to the slit of the pocket or elsewhere, that the instrument be always in a vertical position.

POCKET DISTANCE-INDICATOR.

The first step of the pedestrian sets the works in motion; they continue to act as long as he moves, and stop when he stops. The dial is divided into twelve divisions, which represent so many miles, but can be adapted to record any other measure of distance by means of a governing screw, which is square-headed, so as to be turned by a watch-key; all that is necessary to do is to walk a mile, and then observe the position of the needle upon the dial; the regulator is then turned to the left for *slow*, or to the right for *fast*, until one division on the dial represents exactly the measure of distance chosen. This, of course, will depend upon the length of stride of each individual, and must be regulated accordingly.

When about to start, the needle should be placed at zero, by turning the pointer either backward or forward with the finger.

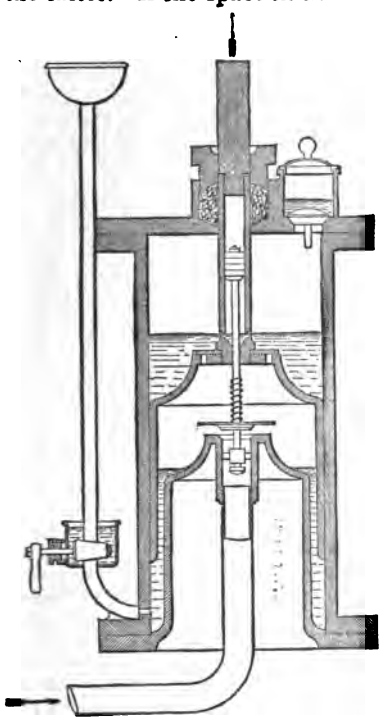
Price, in nickel, $5.25; in silver, $6.50.

AN OYSTER PATENT.

ONE of the great troubles which oystermen have to contend with is the starfish. This rapacious enemy destroys thousands of bushels of oysters every year, and no device has heretofore proved effective as a protection. But the ingenuity of a Connecticut Yankee has at last triumphed. Mr. Oliver Cook, of Darien, Ct., has lately obtained a patent on the subject. His invention consists in spreading a net, under water, on the ground composing the oyster bed. Mr. Starfish puckers his fingers together squeezes himself up through the meshes of the net, and then extends his digits again. Being now upon the upper side of the net, he will be infallibly captured whenever the oysterman raises the net to the surface. This is to be frequently done until the enemy is cleared from the coast, when the oysters at once begin to laugh and grow fat. (83)

A NEW AIR-PUMP.

IN the ordinary air-pump the air withdrawn must be expelled either with the atmosphere or with another cylinder in which a pressure less than the normal is maintained, and hence, before this can be done a sufficient pressure must be imparted to it in order to cause it to raise the weight of the valves as well as of the column of atmosphere outside the latter. If the space in the air-pump cylinder could be indefinitely diminished, the air which would be contained might be compressed so as to lift the valves over when extremely rarefied at the end of the stroke. But in practice the piston does not exactly fill the cylinder, and there always remains at the bottom a certain quantity of air which expands on the return stroke, fills the cylinder, and there maintains a certain pressure, hindering the entrance of the air withdrawn from the receiver, and hence the continuity of the exhausting operation.



NEW AIR-PUMP.

Mr. Robert Gill's new machine, shown in our engraving, is remarkable for the fact that it avoids the above difficulties and completely expels the air at each stroke of the piston. The interstices between piston and cylinder are filled with a non-evaporating liquid, and all the joints are covered with the same. The bottom of the cylinder is well-shaped, leaving an annular space between its exterior and the inner periphery of the cylinder. At the upper part of this portion is a valve which alternately opens and closes the pipe leading to the receiver to be exhausted. The stem of this valve carries a leather piston which fills a bore in the

main piston, so that the valve opens when the latter rises and shuts when it descends. The spiral spring on the valve-stem serves to keep the valve closed during a portion of the ascending stroke, for reasons further on explained.

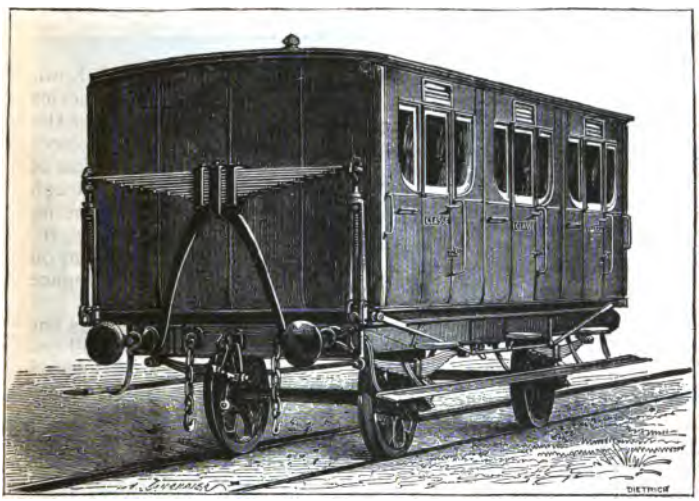
The main piston is hollow and cylindrical, and a shoulder on its rod carries a leather disc which covers a series of perforations in a copper plate forming the top of the piston. The little piston on the valve-stem has grooves on its sides, so as not to cause too great a compression of air in the main piston-rod, and the stem in passing through the main piston does not fit exactly, a small space being purposely left. On the cylinder cover an automatic, inwardly-opening escape-valve is provided. As shown, oil is poured in above the piston, and in the annular space beneath.

Then the main piston begins to ascend the spring as the valve-stem holds the valve shut and prevents the oil entering the tube. As soon as the piston reaches a certain height, however, the level of the oil in the annular space falls, and at that moment the function of the little piston in the main road becomes sufficient to extend the spring and open the valve. This brings the parts as shown in the diagram.

The cavity below the piston being in the beginning completely filled with oil, and the only joints through which the air could enter being covered with the same liquid, it is clear that the space formed under the piston must be free from air. Into this, however, the air from the receiver enters through the pipe, while at the same time the air above the piston, being compressed, escapes by the upper valve. As the pressure is greater above the piston than below, a small quantity of oil escapes round the stem of the little piston, and falls into the inferior annular space.

At the beginning of the descending stroke the air-valve is shut by its piston, and the escape-valve by its own weight and the atmospheric pressure. The space below the piston diminishes constantly during the stroke. Finally, as at the beginning of the ascending stroke, all the lower space is filled with oil, and as a slight addition to the contents has been made, as above noted, it results that when the piston reaches the end of the stroke all the air withdrawn from the reservoir is expelled through the piston perforations, together with the excess of oil. As the piston rests accurately on the bottom, no empty space is left, and all the air, however rarefied, is expelled. This continues until as near a perfect vacuum is formed in the receiver as can be appreciated by ordinary instruments.

GIFFARD'S NEW RAILWAY CAR.



GIFFARD'S RAILWAY CAR.

M. HENRI GIFFARD, inventor of the celebrated Giffard Injector, has succeeded in constructing a railway car, the body of which is so supported on springs that all oscillation and jarring is entirely obviated, and the passengers within are enabled to read, write, and otherwise employ themselves with as much facility as if not in motion. Our engraving is prepared from a photograph of one of these vehicles, now in use on the railway between Paris and Lille, France. The platform is supported on heavy springs of its own, and carries at each extremity standards, which in turn are surmounted by ponderous leaf-springs, to the ends of which are attached the adjustable rods by which the body of the car is suspended. It was found on a first trial that the peculiar horizontal oscillation which is so very fatiguing to the traveler was entirely suppressed, and that a light vertical elastic movement which remained was easily obviated by adjusting the suspending rods.

The weight of the car is somewhat more than that of those ordinarily employed on European railroads, and its cost is higher.

UNDERGROUND RAILWAY, NEW-YORK CITY.

THE UNDERGROUND RAILWAY, NEW-YORK.—GREAT ARCH AT 95TH STREET.

By an act of the Legislature of the State of New-York passed in 1872, the construction of an Underground Railway under Fourth Avenue, between the Grand Central Depot, 42d street and the Harlem River, a distance of 4¼ miles, was authorized, one-half of the expense to be paid from the city treasury, and the remainder by the New-York & Harlem Railway Company. The work has been vigorously prosecuted, is now almost completed, and the line embraces some of the finest examples of engineering construction. Several millions of dollars have thus far been expended upon the work. The road-bed inside of the walls has an average width of fifty-feet, and accommodates four tracks, intended for the use of New-York and Harlem, New-York Central & Hudson River, and New-York, New-Haven & Hartford Railways. Two of the tracks are designed for local accommodation, and commodious passenger stations, built under ground, have been constructed at various convenient points along the line. The supervision of the work has been entrusted to a State Engineer Commission, consisting of Alfred W. Craven, C.E., Allan Campbell, C.E., the Engineer of the Department of Public Works, and the Engineer of the New-York & Harlem Railway Company.

Our engraving is an elevation of the great arch near the junction of 95th street and 4th avenue, where the four railway tracks converge within a narrow rock cutting and enter a gigantic tunnel of 68 feet span, then again diverge, two tracks going through a central 25 feet tunnel, and two other separate side tunnels being provided for the two other tracks.

By a subsequent act of the Legislature, perfected in May, 1874, authority was given for the construction of another Underground Railway, beneath the surface of the great thoroughfare of Broadway, viz., from a connection with the Fourth avenue work, southerly, to the Battery, 4½ miles. This section pertains to the Broadway Underground Railway Company, and covers probably the most valuable railway route in the world, extending as it does through the heart of the city, where both the local and transient population is very great. The railway will extend in one continuous line, under the surface of Broadway, from the Battery, at the southern extremity of the city, to Central Park, at the junction of Broadway and 59th street and 8th avenue, with a short lateral branch at 42d street to the Grand Central Depot and the Fourth Avenue Underground Railway. The Eastern, Western, and Central sections of the city will thus be locally accommodated with rapid transit, and fast passenger trains will run through the entire length of the city.

The act provides that the Broadway Underground Railway shall be constructed under the supervision of a Board of State and Municipal engineers and officers, consisting of Gen. Geo. S. Greene, C.E., Allan Campbell, C.E., James P. Kirkwood, C.E., and the Department of Public Works.

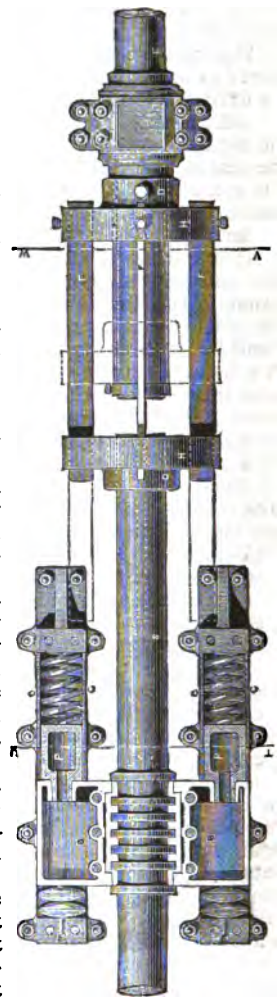
The work on the Broadway Underground Railway will, it is expected, soon be commenced, the financial negotiations being well in progress, one-half of the money necessary for the construction having been secured. The authorizing law is rather stringent, requiring that the entire money necessary for the building and equipment of the line shall be secured before the construction of any portion is begun. The completion of this line will greatly promote the convenience of the people, and add essentially to the attractions and prosperity of the metropolis.

The New Post-Office, at the junction of Broadway and Park Row, is now nearly completed. The basement portion of the edifice on Broadway has been specially constructed with a view to a communication with the Broadway Underground Railway, and when the latter is completed, the Postal Cars from all the different railways mentioned will run directly into the Post-Office. This will be a great public convenience, as it will materially facilitate the dispatch and receipt of the mails.

The work of constructing a tunnel under the Hudson river, from the foot of Fifteenth street, in Jersey City, to the foot of Canal street, New-York, 400 feet, thence to a connection with the Broadway Underground Railway, was begun in December, 1874, but was arrested by legal proceedings.

RECENT IMPROVEMENTS IN SCREW PROPELLERS.

THE excessive vibration ever present in large steamers propelled by full-powered engines causes waste of power, discomfort to passengers and crew, and is very destructive to the ship herself, shaking her joints and seams loose, and making a serious addition to the repairs and maintenance bills. The cause of vibration is perceptible enough. A series of rigid iron blades are rotated near the surface of the water, itself quite inelastic and constantly moving in diverse currents; the screw is rigidly united to the ship and to the reciprocating parts of the engines, the three structures being all subjected to a series of strains, crossing and recrossing each other in various directions, and perpetually altering in magnitude.



NEW ELASTIC SCREW-PROPELLER SHAFT MECHANISM.

This invention is an attempt to introduce elasticity in two directions, crossing each other at right angles, thus securing what may be termed universal elasticity, inasmuch as every movement of the ship will come more or less under its influence. The two elasticities are respectively longitudinal and torsional; the former is obtained by fitting the thrust-blocks, not as rigid fixtures to the ship's hull, as at present, but in slides, and bearing against springs. The latter is provided by making the screw shaft separate from the engine shaft, and conveying the rotative power of the engines to the screw shaft through flat

flexible steel blades. working between a pair of discs placed respectively on the screw and the engine shafts. Referring to the drawings, E is the engine and S the screw shaft; D D are discs on the shaft, hooped with steel hoops H; that on the engine shaft can be moved along the shaft nearer to or further from the screw shaft; the other disc is a fixture. Each disc has a series of radial notches cut in. Into these notches flexible steel blades F are passed, and secured in the engine or movable disc by set screws. The reason for making one disc movable along the shaft is to enable the engineer in charge to alter the amount of torsional elasticity, which is, of course, proportionate to the length of the flexible blades, F F, between the two discs; one degree of flexibility may be suitable at one time, and a greater or less degree at another, and when a change in the state of the sea or the immersion or position of the ship as regards the "scend" of the sea appears to call for it, the engineer in charge can, by slacking the set screws shown on the engine-shaft disc, release it, and it can then be shifted nearer to, in order to diminish, or farther from the screw-shaft disc, in order to increase, the amount of torsional elasticity in the shaft.

The second feature under notice is longitudinal elasticity. The thrust-block has a pair of lugs, B B, working in guides similar to those of a locomotive piston-rod; to each lug is attached a plunger-rod or stud, P, which bears against the springs inclosed in the cylinders, C C, shown in section to leave the springs visible. The recoil strains due either to stoppage or reversal of the engines, are taken up both by cup-washer springs put behind the lugs as shown, and also the inventor contemplates the use of a pair of air cylinders bolted to the guides, in which pistons packed with cup leathers will move and be connected to the block lugs by rods going through the washer springs; the cylinder ends will be closed and fitted with air cocks so made that the outlet can be increased or diminished, but never actually closed. The cup leathers will be fitted to allow the free advance forward of the thrust-block, but to oppose its return more rapidly than the air can escape through the cylinder cock. Other advantages claimed for this invention are that, for one thing, from the gradual absorption of the strains to which the shaft is subjected there is less chance of the shaft being fractured when subjected to the momentum strains of the reciprocating parts of the engine; at one time working without opposition, when, in heavy weather, the screw is raised out of the water, and in another second opposed by a great resistance, caused by the drowning of the screw

in the roll of a wave. For another thing, that the shaft, having more immunity from vibration, will be less affected by crystalline deterioration, and will therefore have less need of annealing to restore fibrous toughness.

(114)

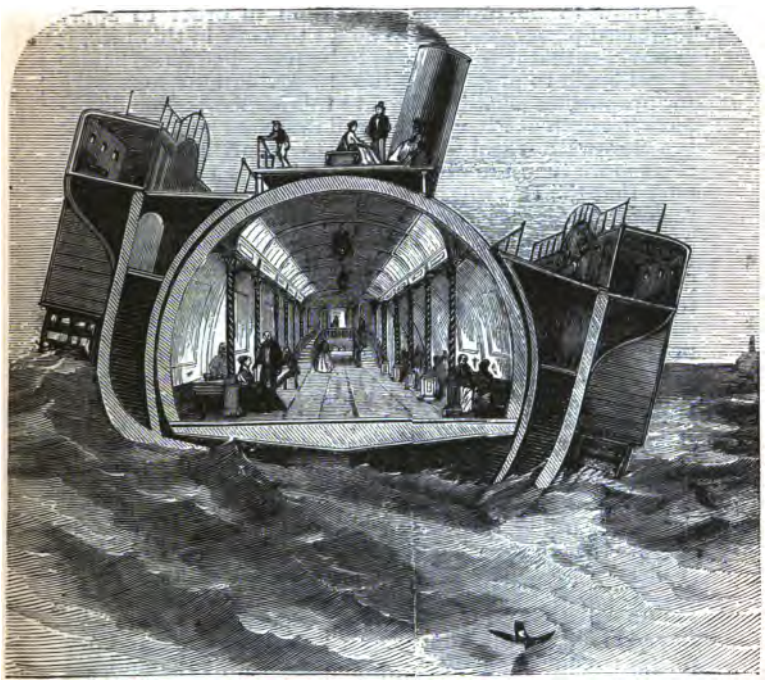
THE NEW SWINGING-SALOON STEAMER, "BESSEMER."

ON another page we illustrate a new-twin steamer, designed to relieve passengers from sea-sickness, and we here engrave a section of the new ship, designed for the same purpose by Mr. Henry Bessemer, of Bessemer steel fame. This vessel exhibits the most superior engineering, and is expected to enjoy a large traffic, in running between England and France.

The Bessemer saloon steamer was recently launched in a nearly completed state, from the yard of Earle's Shipbuilding and Engineering Company, Hull. She has very much the appearance of a breastwork turret ship. She is shaped alike at bow and stern, and for 48 feet from each end she has a freeboard of about 3 feet only. Her total length at the water-line is 350 feet, and the raised central portion, rising 8 feet above the low bow and stern, is 254 feet long, and extends the whole width of the vessel, 60 feet over all. The swinging saloon, 70 feet long, is in the centre, and the engines and boilers which drive the two pair of paddle-wheels are stowed in the hold at either end of the raised portion of the vessel.

The nominal horse-power is 750, working up to 4,600, sufficient, it is estimated, to drive the vessel 18 or 20 miles an hour. The two pairs of paddle-wheels are placed 106 feet apart, and each wheel is 27 feet 10 inches in diameter, and fitted with 12 feathering floats.. The saloon is entered from two staircases leading to a landing, connected with the saloon by a flexible flooring. The saloon itself is upheld on its axis by four steel supports, one at each end, and two close together in the middle. The aftermost of the two central supports is hollow, and serves as a part of the powerful hydraulic machinery which will regulate the motions of the saloon. Without entering into a long technical explanation, it is enough to say that Mr. Bessemer has constructed some machinery which will cause the valves, the opening and shutting of which will adjust the saloon, to work automatically. The interior of the swinging saloon measures 70 feet long, 35 feet wide, and 20 feet high.

As to the question of the double set of paddle-wheels, and their effect upon the speed as compared with a single pair of wheels, Mr. Reed's view is as follows: When a ship is being propelled at a uniform speed by the exertion



THE "BESSEMER" STEAMER, WITH SWINGING SALOON.

of a given constant power of engine, all that the engine does is to prevent the speed from decreasing, as it would do if the propelling power were removed. Were that power removed, the ship would not suddenly stop, but be gradually and slowly brought to rest by the resistances opposed by the water to her progress through it. In point of fact, therefore, in the case of a paddle-wheel steamer at full speed, the ship herself carries the wheels rapidly past the surrounding water; and before the wheels can begin to propel at all, the engine must cause them to revolve with a corresponding velocity. If, for example, we take the case of a steamer going at a uniform speed of 14 knots an hour, with 36 revolutions of her engines, we assume that 30 of those revolutions were required for enabling the wheels to overtake the ship, and that the remaining six only are useful for propulsion. These six revolutions no doubt impart a sternward velocity or race to the water of corresponding amount; and if another wheel

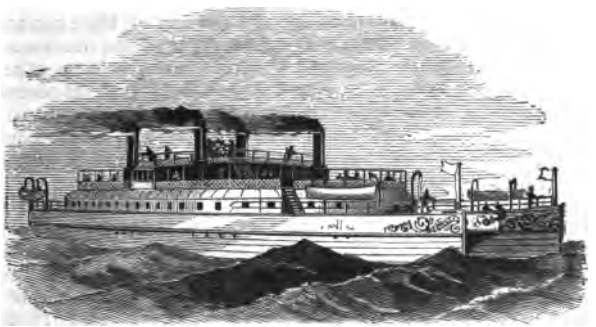
has now to be brought into action in order to apply increased power, and has to be set to work in this race, it is obvious that it will require to be turned 36 times before it will begin to propel, and the few revolutions necessary for propulsion must be added to this number. The difference between the two wheels will therefore simply be that the sternward wheel will require to revolve a few revolutions more than the other before it begins to propel, but after that the two will be upon equal terms, excepting as regards any losses from friction, etc., due to the extra speed of revolution. This is Mr. Reed's view, and, if he be correct, the speed realized by the Bessemer will probably prove at least equal to that of the fastest paddle steamers in the world; although, at the same time, the designer considers the very light draft and great beam of the ship, and the extra weights which have been found necessary in connection with the saloon and its machine beyond what he was called upon to design for, will in some degree detract from the speed which has been predicted by the admirers of the vessel.

COMPARATIVE HEALTH OF WORKING MEN.

FROM a report of Dr. Walter Lewis, a noted English physician, regarding the health of French working men, it appears that the percentage of deaths from consumption in 1,000 cases collated, is for various trades as follows: Exposed to vegetable or mineral emanations, 176; to dust and fine particles, 145; sedentary occupations, 140; employed in close work-shops, 138; exposed to hot and dry air, 127; requiring active muscular exercise, 89; requiring exertion of voice, 75; working in open air, 73; exposed to animal emanations, 60; the remainder being made up of persons working in a stooping posture, exposed to sudden movements of the arms, or exposed to watery vapors. Concerning the effect of various employments on the eyesight, it seems that the sense is injured by those working with polished metals, looking-glasses, etc. The smallness of objects and intensity of direct or reflected light is also a cause of impaired vision; while astronomers who study the sun have become totally blind, and opticians who daily exercise and test spectacles, etc., engravers, watchmakers, etc., are liable to amaurosis and amblyopia.

COLORING GLASS WITH GOLD.—Payard points out that the tints produced in glass by gold depend on the temperature to which the glass is exposed, and to a certain extent also on the nature of the material of which the mold is made. Low temperatures give a bluish color, but this can, on renewed heating, be brought to splendid crimson,

A NEW TWIN-STEAMER.



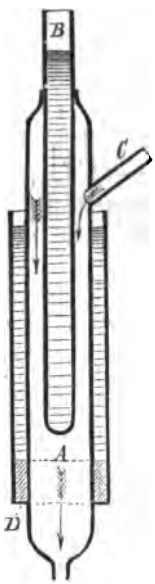
THE NEW TWIN-STEAMER "CASTALIA."

THE English Channel, between the coasts of England and France, a steaming distance of only 28 miles, is notorious as one of the roughest sheets of water to be anywhere found. Few passengers escape an attack of severe sickness in making the trip, although its duration is only from two to four hours. Various forms of boats have been suggested for the purpose of rendering the voyage more comfortable, and two of them have been put into execution during the past year. One of these vessels, the "Castalia," built on the largest scale and at great expense, is a twin-ship, propelled by paddle-wheels placed between the connecting girders; and she is especially designed to sail without pitching or rolling in any sea, however rough. The engraving gives an idea of her appearance on the water and the extent of her accommodations. She is 296 feet long and 60 feet wide over all, each hull having a width of 17 feet; she is also double-ended, to avoid the necessity of turning in entering or leaving a harbor. Her cabins and saloons are handsomely appointed; and she was much commended as a successful sea-boat in her preliminary voyage from the Thames, where she was built, to Dover, her intended point of departure for the continent. Thirteen knots an hour is to be her speed, according to the expectations of her designer (Captain Dicey), and the builders and engineers.

Preliminary trials have been made, but her boilers were found deficient in steaming power, which is now being increased. The other new ship, the "Bessemer," will be found represented on another page.

A NEW OZONE GENERATOR.

THIS apparatus consists of a tube, A, of thin glass, 6 inches in diameter and about 1 foot in length, drawn to a point and open below. In the upper portion is a test-tube, B, arranged as shown. The tube C serves to introduce the air or oxygen to form the ozone, and the exterior of the apparatus is covered with a sleeve, D, having an india-rubber bottom.



The outer sleeve or tube is filled with a liquid which is a good conductor of electricity, either a weak solution of sulphuric acid, or a hydrochloric solution of chloride of antimony. The annular space in tube A is empty, and the tube B is filled with the same liquid already mentioned.

If the .one of the poles of a Rhumkorff coil be plunged into D and the other into B, the electricity at high tension not being able to pass in sparks across the glass partition, traverses the inner annular space in its entire extent as a current, thus affecting the dry air or oxygen therein introduced from a gasometer through the tube C.

A coil 9 inches in length excited by 3 medium-sized Bunsen elements suffices, it is said, to produce excellent results. The ozone escapes through the narrowed end of the tube, and can thus be brought in contact directly with the body upon which it is desired to react.

TOW DRESSINGS.

DR. ALPHONSE GUÉRIN, an eminent surgeon of the Hotel Dieu in Paris, has recently presented to the French Academy of Sciences a remarkable memoir on the influence of atmospheric germs on surgical maladies, in which he strongly advocates tow dressings for wounds. He states that, when this material is packed upon the injured part, the pus is completely preserved from putrid fermentation. He uses the tow in brief as a filter for the air, which circulates freely through it, and in fact produces an arrangement precisely analogous to the cotton-wool respirator mentioned by Professor Tyndall in his paper on haze and dust.

BOTANY AND HORTICULTURE.

QUALITIES MOST ESTIMABLE IN THE ROSE.

A ROSE, taking all things into consideration, is, perhaps, the most splendid of flowers. Throwing aside the national affection for our emblem, the rose is appreciated for itself. It has qualities peculiar to itself. It is beautiful, from the moment when the color peeps from its green covering, until its flower is complete—handsome in all its stages. Its perfume is unequaled; and whether it be a simple bud or bloom in the hand, a bush in the border, a tree on the lawn, or climbing the pillar, or winding around the archway, or covering the front of a house, it is equally admired.

In estimating the various qualities which give value to the rose, we are almost inclined to place that of continual blooming first, even before perfume, although without this a rose loses its great charm; but continuous flowering is of so much importance, the prolonging of the beauties of the garden is so essential, that we think it of more consequence than any other feature. See a garden, liberally planted with summer roses, in a blaze of beauty in June or July, and it is a second paradise; but what is it before or after that period? The rose trees bereft of adornment are eyesores; they are, in fact, in the way until they bloom again. But see the same or another garden, judiciously supplied with continuous blooming roses of the nature of the common China, and we have them in flower the last of all our favorites. A frost that will kill down dahlias to the ground will only injure the flowers of the rose; the buds are scarcely damaged, and it is not an uncommon thing to see continuous blooming roses flowering in a mild autumn up to Christmas; and be it remembered that we have now hundreds of beautiful varieties possessing this valuable quality.

We now come to a quality which is of more importance than it at first seems—namely, thickness of petal. The advantages of this are, first, that, whatever be the color, it is more dense than it can be in a thin petal; but apart from the superiority of color, thick petals are more lasting than thin ones, and sun and winds have less effect upon them. A rose with thick petals will remain perfect for days, while thin ones are burnt or shriveled in a few

hours; and we hardly know of a more disagreeable fault than speedy decay. To see the ground strewed with petals in a few hours, and the plants disfigured by the remains of decayed flowers, is very far from pleasant, and this is inevitably the case with thinly petaled roses.

Upon the whole, the qualities of a good rose are—continuous blooming; thick, smooth-edged petals; flowers round, forming half or two-thirds of a ball, very double and full-faced, very symmetrical and imbricated; wood short-jointed; color dense, that is, whatever its shade be, the color decided; and if striped or blotched, the stripes or blotches well defined. (124)

CARNIVOROUS PLANTS.

MRS. MARY TREAT gives, in the *American Naturalist*, an interesting account of her observations of the habits of the plant known as sundew *(drosera filiformis)*, which she found in July last, in Atlantic county, N. J. These plants appear to be most remarkably endowed. To all the usual functions of plants, certain animal instincts and propensities are added, such as the power to seize, kill, and suck the blood of insects, and to grasp and eat raw meat, etc.

Our author says of the plant: "It was in full bloom and growing as thick as it could well stand, on either side of an extensive cranberry plantaion. This charming plant, with its pretty pink blossoms, together with the dew-like substance exuding from the glands (the glands surmount the bristles or hairs which cover the long, thread-like leaves), was one of the most beautiful sights I ever beheld. From former observations I had supposed this plant caught only small insects, but now found I was mistaken; great asilus flies were held firm prisoners, innumerable moths and butterflies, many of them two inches across, were alike held captive till they died—the bright flowers and brilliant, glistening dew luring them on to sure death.

"I experimented with three species of these plants—*D. filiformis*, *D. longifolia*, and *D. rotundifolia*.

"At 11.30 A.M., I fixed living flies on the leaves of *D. longifolia*. At twelve o'clock and forty-eight minutes, one of the leaves had folded entirely around its victim, and the other leaves had partially folded, and the flies had ceased to struggle. By half-past two, four leaves had each folded around a fly. The leaf folds from the apex to the petiole, after the manner of its venation. I tried mineral substances, bits of dry chalk, magnesia, and pebbles. In twenty-four hours neither the leaves nor the bristles had made any move like clasping these articles. I wet a

piece of chalk in water, and in less than an hour the bristles were curving about it, but soon unfolded again, leaving the chalk free on the blade of the leaf.

"The bristles around the edge of the leaf of *D. rotundifolia* are longer than on those of *D. longifolia*, but the leaf of the former does not fold around a fly as it does in the latter—simply the bristles curve around the object, the glands on the ends of the bristles touching the substance, like so many mouths receiving nourishment.

"Half-past ten A.M., I placed raw beef on some leaves of *D. rotundifolia;* by one o'clock the inner bristles were curving about it, and the longer bristles, on the outer edge of the leaf, were slowly curving upward. By nine o'clock in the evening, all the bristles of three of the most vigorous leaves were clasping the beef, almost hiding it from sight, while an equally vigorous leaf made no move like clasping a bit of dry chalk. At ten o'clock in the morning I placed bits of raw apple on some of the leaves of the last named species; by nine o'clock in the evening part of the bristles were clasping it, but not so closely as the beef. By ten o'clock next day, twenty-four hours, nearly all the bristles were curved toward it, but not many of the glands were touching it. So it would seem that these plants are really carnivorous—that they prefer and absorb animal substances through their leaves. And Mr. Darwin says that, by pricking a point in the leaf of *drosera*, he can paralyze half of it, and this indicates nerves!"

PLANTS THAT FEED ON ANIMALS.

RECENT observations by Dr. Mellichamp, at Bluffton, S. C., upon the *Sarracenia variolaris*, which abounds in that locality, give some new and curious results. This species of the pitcher-plant has an elongated, conical, erect leaf, with a broad lamina curved over the opening, and a wide longitudinal wing upon one side the whole length of the tube. The upper portion is veined with purple, the intervening spaces being white and diaphanous. Dr. Mellichamp establishes the following points: The base of the tube secretes a watery fluid, which is not sweet nor odorous, but which proves quickly fatal to all insects that fall into it. The whole inner surface is covered with very minute, closely-oppressed prickles, perfectly smooth and pointed downward, which render it impossible for an insect to ascend by walking, even when the leaf is laid nearly horizontal. Within the somewhat dilated rim of the tube there is a band a half-inch in width, dotted with a sweet secretion, attractive to insects, but not intoxicating. This also extends down-

ward along the edge of the outer wing to the very ground, thus alluring many creeping insects, and especially ants, to the more dangerous feeding ground above, where, once losing foot-hold, it is impossible to regain it. Even flies escape but rarely, the form of the tube and lid seeming to effectually obstruct their flight. As the result, the tube becomes filled to the depth of some inches with a mass of decaying ants, flies, hornets, and other insects. Within this there is always found a white grub feeding upon the material thus gathered, perhaps the larva of a large fly which has been observed to stand upon the edge of the tube and drop an egg within it. Soon after the full development of the leaf, the upper portion becomes brown and shriveled, which is due to still another larva, the young of a small moth, which feeds upon the substance of the leaf, leaving only the outer epidermis, and works its way from above downward till in due time it spins its cocoon, suspending it by silken threads just above the surface of the insect débris at the bottom. The whole forms a series of relationships and an instance of contrivance and design, the full purport of which is still by no means fully understood. Other species of the genus, as also the allied *Darlingtonia* of California, manifest the same purpose of insect-capture, whatever the final object may be. (144)

MICROSCOPIC CRYSTALS IN PLANTS.

BESIDES the familiar bundles of needle-shaped crystals, called raphides, dispersed throughout the cellular structure of certain plants, there are in the seed-covers and leaves of several orders of plants, and in the pods of the bean family, multitudes of prismatic crystals of extreme minuteness, which have hitherto escaped destruction. In the horned poppy, these crystals are as small as $\frac{1}{8000}$ of an inch in diameter. In the gooseberry and elm, they are $\frac{1}{3000}$ of an inch; in the black currant, about half as large; in the black bryony, they are about $\frac{1}{1500}$ of an inch in diameter, thickly set at regular distances throughout the seed-covers. In the gooseberry, they are so distinctly and regularly placed in the outer skin, each crystal in a separate cell, that they present the appearance of crystalline tissues. In plants of the bean family, the size is variable, the average being about $\frac{1}{8000}$ of an inch. In the garden pea, they are much larger. These crystals appear to consist chiefly of oxalate of lime, sometimes carbonate. Raphides are mainly phosphate of lime.

Plants most relished by animals are found to be especi-

ally rich in these microscopic crystals. In a piece of the midrib of a clover leaflet, $\frac{1}{10}$ of an inch in length, Mr. Gulliver, who has added more than any other to our knowledge of these minute but important products of vegetable action, has counted 10 chains of crystals with 25 in a chain, making 250 in all, or no less than 17,500 to the inch. In like manner 21,000 crystals were reckoned for one inch of the sutral margin of a single valve of a pea pod. The pod had four such margins, each three inches in length; so that in a single pod there must have been as many as 250,000 crystals. In view of the marvelous number of these crystals, as well as their regularity and constancy, Mr. Gulliver believes it no longer possible for physiologists to maintain that such structures are accidental freaks of nature; of no relation to or value in the life and use of the species.

THE PITCHER-PLANT.

IN a paper read at the American Association, Prof. C. V. Riley gives the following description of the pitcher-plant *(Sarracenia)*: The leaf of this plant is a trumpet-shaped tube, with an arched lid, covering more or less completely the mouth. The inside is furnished with a perfect *cheveaux-de-frise* of retrorse bristles, commencing suddenly about an inch from the base; thence decreasing in size until, about the middle to the mouth, they are so short, dense, and compact, as to form a decurved pubescence, which is perfectly smooth and velvety to the touch, especially as the finger passes downward. Running up the front of the trumpet is a broad wing, with a hardened border, parting at the top and extending around the rim of the pitcher. Along this border, but especially for a short distance within the mouth, and less conspicuously within the lid, there exude drops of a sweetened, viscid fluid, which, as the leaf matures, is replaced by a white, papery, tasteless sediment or efflorescence, while at the smooth bottom of the pitcher is a limpid fluid, possessing toxic qualities. The insects which perish in this liquid are numerous, and of all orders, but ants are the principal victims. The plant, however, is omnivorous as regards insects, and Prof. Riley has found in the fluid, at the bottom of the pitcher, katydids, locusts, crickets, cockroaches, flies, moths, and even butterflies, in a more or less recognizable condition.

WOOD ASHES are stated to be an effective remedy for currant worms. Dust the bushes in the morning with the dry ashes. Three applications, thoroughly dry, will be sufficient.

NEW CLIMBER FROM THE FEEJEE ISLANDS.

CAMPSIDIUM FILICIFOLIUM.

THIS is a provisional name for a very elegant, slender-habited climber, the flowers of which are as yet unknown. It is, however, referred to *Campsidium*, from the resemblance borne by its foliage to that of known species of the genus. The present plant, of which a woodcut from Mr. Bull's catalogue is annexed, has been raised from seeds received from the Feejee Islands. It has a slight, woody stem, furnished with opposite imparipinnate leaves, which, including a petiole of about an inch, measure five inches long, and consist of from nine to twelve pairs of small ovate leaflets, which are deeply cut into two or three lobes on each side, the larger lobes being sometimes also toothed. These leaves, from their small size, narrow linear outline, and the size and arrangement of the leaflets, bear very considerable resemblance to the fronds of some of the small, slender, pinnate ferns, whence the name which has been given to it. It has an elegant and pleasing character

THE FLORA OF THE BLACK HILLS.

CUSTER describes the botanical wonders of the Black Hills country, Dakota. Of "Floral Valley" he says that it surpasses in its display of flowers any public or private park he had ever seen. Every step of the march up that valley was amid flowers of the most exquisite colors and perfume. So luxuriant in growth were they that the troopers plucked them without dismounting. At one of the halting-places, General Forsyth plucked, choosing at random, seventeen beautiful flowers, of different species, and within a space of twenty feet square. The same evening, while seated at the mess-table, an officer called attention to the carpet of flowers under foot, and the question arosé, how many different species could be plucked by the company without leaving their seats at table. Seven beautiful varieties were thus gathered. Prof. Donaldson, botanist of the expedition, estimated the number of flowers in bloom in Floral Valley at fifty, while an equal number of varieties had bloomed or were yet to bloom. The number of trees, shrubs, and grasses, was twenty-five, making the total flora of this valley embrace 125 species. Through this beautiful valley meanders a stream of crystal water, so cold as to render ice undesirable, even at noonday. The temperature of two of the many springs found flowing into it was ascertained to be 44° and 44½° respectively.

SENSATION AND MOTION IN PLANTS.

TREATING of the vital phenomena which are common to plants and animals, the eminent French physiologist, Claude Bernard, observes that Linnæus's criterion of animality, viz., sensibility and mobility, is not in accord with facts. There are many plant forms on the boundary between the animal and the vegetable worlds, for instance, the zoospores of the algæ, which have the power of motion. Then the antherozoids, particularly the œdogonium, studied by Pringsheim, manifest the faculty not only of motion in general, but even of motion toward a definite object—in other words, show all the appearances of voluntary movement. As instances of mobility in plants, the author further cites the movements of the stamina of the *Berberis* (barberry), the *Drosera*, the *Dionœe muscipula* (fly-catcher), and the oscillating sainfoin *(Hedysarum gyrans)*.

Sensibility, too, is found in several plants. The *Mimosa pudica* (sensitive plant) is the most prominent instance of this. This plant reacts against any irritation by folding up its leaves, which again are spread out soon after

the exciting cause is removed. It is a curious circumstance that most of the agents which excite sensibility in animals have a like effect on the mimosa: thus, it is affected by sudden shock, by burning, by the action of caustic, by electrical discharges, etc. Nay, the same agents, such as chloroform and ether, which deaden sensibility, or assuage pain in animals, destroy the mimosa's power of reaction. Vegetal anæsthesia is produced by the same means as animal anæsthesia.

There are other plants beside the *Mimosa pudica* which manifest this curious property of reacting against irritation, for instance, the leguminosæ of the genera *Smithia*, æschynomene, desmanthus, *Robinia pseudacacia*, and the *Oscalis sensitiva* of India. From all this it follows that the power of movement and sensibility are functional properties which can not strictly serve as a distinction between the vegetable and animal worlds.

FERTILIZATION OF PLANTS.

M. HOOIBRENK'S process for facilitating the fertilization of plants has, according to the report of M. Beer, been successfully tried in the Botanic Garden, Vienna. The process consists in touching the stigma of the flower, just before it blooms, with a pencil dipped in honey, or, better still, with honey mingled with the pollen of the plant which is being operated on. The process has succeeded admirably, it is stated, on fruit-trees, and even on certain particular branches of trees which had never borne; on the portions thus treated, fruit formed in natural course, while other parts remained in their normal condition. The effect may be explained by supposing that the honey retains the pollen-grains on the stigma, and thus favors the formation of the indispensable pollen-tubes.

M. PLANCHON, with whose labors our readers are familiar, has succeeded in tracing directly to an importation of American vines into France, in 1862, the Phylloxera pest now ravaging the vineyards of that country. He has found at Roquemare a plantation of 154 American stocks which dates from that year. All the other vines in the neighboring districts have been nearly destroyed, while these American stocks are intact. Though their roots are covered with the parasite, their foliage and fruit are very good. It was at Roquemare that the grape vine disease first made its appearance in 1863, and then extended in every direction. It begins to be admitted now in France that the only protection against the Phylloxera is to be found in the introduction of American vines.

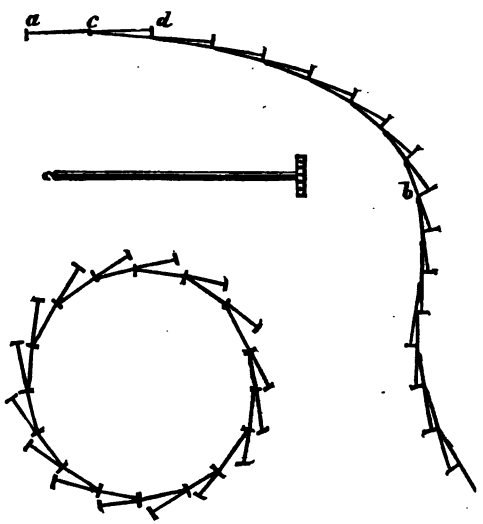
VASE FOR FLOWERING BULBS.

THE flowering bulbs which decorate our mantel-pieces are being much inquired for. Among the best for indoor growth are narcissus (such as the paper-white and *soleil d'or*), hyacinths, snowdrops, crocuses, and tulips. All these may be potted in a light compost, and the two first mentioned grown well in glasses of water. A more effective method of displaying their beauties is the use of a perforated vase, as shown in our engraving. It is pierced with holes, opposite each of which a flower bulb is placed; and the intervening spaces are filled with compost. Some use moist sphagnum (moss) in place of soil; and if the bulbs are well ripened, it answers nearly equally well. A hyacinth bulb, planted at the top, finishes off the arrangement in a pleasing and artistic manner.

PERFORATED VASE FOR FLOWERING BULBS.

LAYING OUT CURVED WALKS.

In laying out grounds, whether they are the rough and picturesque, or the smooth and polished, nothing is more essential to good appearance than graceful curves to the walks. Irregular and angular curves will spoil any grounds. We often receive inquiries for an easy and practicable mode for making these curves. Where convenient, it is always best to draw the plan first on paper, from actual measurement of the different parts. Where strict accuracy is not required, a good pacer will measure the length, breadth, and other parts with sufficient accu-



racy for a plan. When this is drawn, transfer the principal points to the ground again by pacing. This will serve as a beginning. (In large, expensive places, an accurate plan by a surveyor may be necessary.) The next thing is to make the details and finish of the curves. The best mode is to provide a large number of short wooden pegs, and stick them in the ground at regular distances, deviating from the straight line a greater or less degree, according to the length or shortness of the curve. The cut exhibits this process where the successive and regular deviations from the curved line are desired. At *c* these deviations are slight, and the curve is longer; at *b* they are greater, and produce a shorter and more abrupt curve.

A perfect circle may be laid out in this way, without the usual resort to a line and centre-pin, as shown. A land surveyor may thus run a circle miles in diameter by successive and uniform deviations at each observation taken at regular distances.

We have found the following contrivance a simple one, and to answer a good purpose. Take a light wooden rod, say 2 yards long, with a small wire hook at one end, a slight notch on each side at the middle, *e*, and a graduated cross-bar at the other end.

Small holes are bored into this cross-bar at regular distances, for the insertion of pins. Suppose we wish to lay out a walk, as shown in the upper diagram, commencing with the direction *a c*. Place the rod just described, *a d*, in this direction, and stick in a pin at *a* and at *c*. The deviation of the third pin at *d* can be accurately determined by making a few trials. When thus determined, set the pin in one of the holes of the cross-bar, at the determined distance from the centre, and inserta corresponding pin into the ground. Then slide the rod a yard forward, placing it against the two last pins, and repeat the process. So long as this process is continued, it will form a uniform and perfect curve. If, however, it is desired to pass gradually from a long to a short curve, remove the pin in the cross-bar further from the centre at each successive station.

After some experience, the ease and facility with which curves may thus be extended over grounds in all directions, will be surprising to any one who has not tried it.

Curves in roads are sometimes angular and unpleasing, because laid out merely by guess. By adopting the rule just given, on a more extended scale, a perfect form may be attained, even if the successive stations are merely measured by pacing. (127)

A FLORAL CHAMELEON.

THE French Bishop of Canton has recently sent to the *Jardin d'Acclimatation*, at Paris, a plant whose flower changes color three times a day. It is spoken of as another wonderful evidence of Chinese art in leading nature out of her customary paths. It appears, however, that it is, if not the same, at least not more remarkable than a natural floral freak found in Southern Australia. It is a beautiful flower, similar to our well-known morning glory, with five streaks of color on its bell-shaped calyx. In the early morning the color streaks are pale blue. Toward noon they turn to a rich purple tint, which changes to a light pink during the afternoon. As the day declines the color fades, disappearing entirely after sunset, when the flower closes and dies.

IS THE EUCALYPTUS A FEVER-DESTROYING TREE.

MR. J. BOSISTO, President of the Pharmaceutical Society of Victoria, has fully discussed this question in a paper read before the Royal Society of Victoria. The physical geography of Australia does not differ in its general outline from that of other countries; but in the Eucalypti, remarks Mr. Bosisto, we have a vegetation absolutely Australian, with the exception of its existing in the neighboring island of Tasmania. Any one journeying from Melbourne or from other centres of population into any part of Australia, or diverging to any point of the compass, will immediately observe the Eucalyptus, which constitutes, in fact, four-fifths of Australian vegetation; and it becomes a question whether the immunity of this country from fever maladies is attributable to any special character of its vegetation. Our author appears to think so; and he points out that the Eucalyptus probably exerts its influence in this respect—first, physically, by powerful reaction in absorbing humidity from the earth; by its being evergreen, and in continuous action; by the abundance of its leaf-surface; by its evaporation of water, oil, and acid under a perpetually genial atmosphere; and, chemically, by the power of its volatile oil and volatile acid, abundantly present in the plant and air, to produce peroxide of hydrogen. Mr. Bosisto, as the result of his experiments and observations, is inclined to the belief, then, that there is an active agency existing in the vegetation of Australia over that of other countries. From all we can learn, however, from the limited observations that have hitherto been made in other countries, it would seem that the effects of the Eucalyptus as a fever-destroying tree have been much exaggerated; and, considering the time, expense, risk of failure from an unsuitable character of the soil, and the number of trees that would be requisite to exert any real influence over a malarious district, cultivation experiments with the Eucalyptus do not appear to be a very promising undertaking. (49)

FORMATION OF GUM IN FRUIT-BEARING TREES.

IN the wood of a tree diseased with gum, a great number of vessels are always seen more or less completely filled with gum; sometimes they are entirely filled to a certain length, and sometimes the gum only forms a coating either upon all the periphery or only on one side. The gum first shows itself in very small drops, which gradually increase in size and touch each other, forming small, irregular masses. Recent German observers have

stated that the formation of the gum is due to the disorganization and transformation of the internal part of the wall of the vessel, but the author has come to an opposite conclusion. In examining the wood of an apricot tree from which large masses of gum were extracted, it was found that the vessels were marked with areolated punctures, and with a spiral line due to a thickening of the membrane; also that the surfaces of the masses of gum were marked with deep furrows corresponding with the spiral lines of the vessel wall, and even with small projections according with the punctures. It is thus certain, in the author's opinion, that the gum has poured into the interior of the vessel, and that the marks upon it are imprinted from the vessel wall.

In the production of gum in the cellule by the transformation of starch, it has been observed that, on the first appearance of gum in the cellule, the unchanged starch gathers into small masses, around which forms a thin coating of gum. Gradually the starch diminishes, while the coating of gum increases, until at last the starch disappears altogether, leaving generally a vacant space in the centre of the mass of gum.

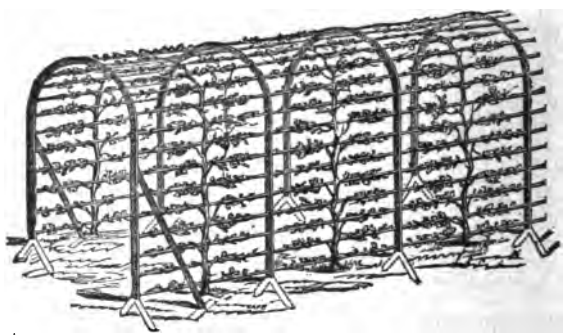
Often the gum, produced in such considerable quantity, is formed neither in the vessel nor in the cellules, but in the spaces between the young tissues, generally between the wood and the bark, yet often also at different depths in the wood. These gum spaces grow at the expense of the neighboring tissues, which suffer important modifications: the cambium, instead of producing woody fibre, forms cellules in which abundance of starch is deposited, which starch subsequently becomes converted into the gum. (4)

PRESERVATION OF WOODEN LABELS.

THE following method of preserving wooden labels that are to be used on trees or in exposed places is recommended: Thoroughly soak the pieces of wood in a strong solution of sulphate of iron; then lay them, after they are dry, in lime water. This causes the formation of sulphate of lime, a very insoluble salt, in the wood. The rapid destruction of the labels by the weather is thus prevented. Bast, mats, twine, and other substances used in tying or covering up trees and plants, when treated in the same manner, are similarly preserved. At a recent meeting of a horticultural society in Berlin, wooden labels, thus treated, were shown, which had been constantly exposed to the weather during two years without being affected thereby.

DWARF FRUIT-TREE BOWER.

THE absence of trees or other vegetation of sufficient stature to afford shade, renders the garden often almost like an oven at noon, and this intense heat, as much and more than the smoke-dried atmosphere, is the cause of many plants thriving so indifferently. A partial remedy might at least be found for this evil by arching over the main walks with wire, and furnishing it with fruit trees as



DWARF FRUIT-TREE BOWER.

shown in our engraving. It can be formed of any height and width to suit different gardens. Of course, however, the minimum height must be 6 or 7 feet, to allow the tallest people to walk under without inconvenience; or in very small gardens such a fruit bower might be erected only 3 or 4 feet high, to be furnished and managed wholly from above, and called the Children's Bower. Such dwarf bowers covered with the choicest fruit would have an exquisite effect looked at from above, and there is no doubt that most fruit would thrive remarkably well upon such trellises, at once useful as beautiful. (127)

THE WASTE OF COTTON-SEED.

MR. AIKIN, of South Carolina, says that the loss by neglecting to save cotton-seed is immense; piles of seed are allowed to decompose and waste at nearly every gin-house, and yet the seed is a valuable manure. For cultivated crops, 30 bushels of cotton-seed in the drill, or 50 bushels broadcast, to the acre will increase the crop considerably. Seed can be rotted by composting it in alternate layers of leaves, straw, and stable manure; 100 bushels of green cotton-seed, mixed in bulk with a ton of soluble phosphate and allowed to remain a fortnight, will make a capital compost for 10 acres of any cultivated crop.

ASCENT OF SAP IN THE BARK OF TREES.

M. FAIVRE has recently performed a series of experiments on the mulberry, hazel nut, and cherry laurel, which he considers goes far to prove the fact that the substances which supply the food of plants have an ascending motion in the bark. For this purpose, he made perfect or imperfect annular incisions through the bark, or detached pieces of the bark, to which buds were attached, or removed entire cylinders of bark from the trunk. The result of the experiments was that the buds always continued to develop when the communication remained uninterrupted with the lower portion of the trunk; while, when this communication was completely destroyed, the buds invariably withered away. If the bud was separated by a perfect annular incision, it withered the more slowly the greater its distance from the incision; and in these cases the starch disappeared entirely from the portions of the wood above the incision between it and the bud. When entire cylinders of bark with buds on them were removed, the buds continued to develop, and even produced branches bearing leaves.

GERMINATION OF LONG-BURIED SEEDS.

Examples have often been met with of seeds which, after having been buried deep in the soil for a great number of years, have germinated when placed in favorable conditions; but it is very rare that the age of these seeds can even be approximatively determined. This renders an observation made by Prof. Heldreich, of Athens, of peculiar interest, since it enables the age of at least 1,500 and perhaps 2,000 years to be assigned to some seeds which have germinated near the silver mines of Laurium. These mines were abandoned 1,500 years ago; and the modern miners, in turning over the scoriæ in search of silver lost by the ancient workers, have brought to the surface seeds of *glaucium* which were buried under three metres of scoriæ. From these seeds abundance of *glaucium* of an unknown species have sprung up, which has been named *G. serpieri*. A curious point is, that on one of these plants double flowers have been found, resembling, according to a figure given by a Greek botanist, the flowers of *trellius*, or a large double ranunculus. It would seem, therefore, that the ancients cultivated this plant.

A COMPOSITION for the destruction of bugs and their eggs, fleas, etc., which has been patented in France, consists of 80 parts of bisulphide of carbon and 20 parts of essence of petroleum.

AGRICULTURE AND RURAL ECONOMY.

THE COLORADO POTATO-BUG.

THE Colorado potato-bug, or *Doryphora decem-lineata*, an enlarged representation of which we herewith present, has for several years past made alarming ravages in the potato crops of the western section of the country. Some forty years ago, it was known in the Rocky Mountains, where it seemed to be indigenous, feeding upon the *solanum rostratum*, or wild potato. When the common tuber was introduced in that region, the beetle soon attacked it; and spreading from one field to another, in 1859 it had reached a point one hundred miles west of Omaha. In 1861 it invaded Iowa, and, crossing the Mississippi in 1864–5, it has since proceeded eastward at the rate of about sixty miles per year; so that it will probably reach the Atlantic, unless some means be found for its extermination, during 1878.

THE COLORADO POTATO-BUG.

Professor Hall, of Chicago, states that the beetle lays its eggs on the under side of the potato leaf. These are speedily hatched. The larva, when full grown, is over half an inch long, very thick in the middle, and tapering towards head and tail. It is of a pale yellow color, often dusky or freckled on the back, with small blackish dots, and along each side are two rows of large black dots. The legs are black, and the head black and shining.

The mature insect, the beetle itself, is nearly half an inch long and a quarter of an inch wide. Its shape is oval, very convex above and flat beneath; of a hard, crustaceous texture, smooth and shining, and of a bright straw color, the head and thorax being sometimes tawny yellow; head and thorax marked with black spots: the wing cases with black stripes arranged longitudinally, five on each case. The antennæ are twelve-jointed; the first five joints are pale or tawny yellow, the remaining joints black, the last joint being small, and sunk into the penultimate one.

The legs are tawny yellow, the hips, knees, and feet being usually black. It requires less than a month to pass from the egg to the beetle state.

Where the bug once gets a footing, it speedily destroys the entire crop. It is believed to effect all its transformations in fifty days, so that a single pair would, if unmolested, produce sixty millions of progeny in a single season. Various modes of preventing its ravages have been suggested. Brushing or shaking the larvæ from the haulm into a vessel is sometimes tried, but this is a laborious and dangerous operation. Dusting the leaves with white hellebore powder is an effective remedy when it is well done; the powder must, however, be freshly ground, as it loses its efficacy when kept too long. Paris-green is also recommended, but both powders are irritating to those applying them, while the latter is extremely poisonous. Birds, it is said, will not destroy the bugs, as the emanations from their crushed bodies are noxious even to human beings, and, it is said, have caused several deaths. The symptoms resemble those caused by the bite of the rattlesnake. The beetle has several insect enemies, especially some varieties of ladybird, which prey upon its eggs and larvæ.

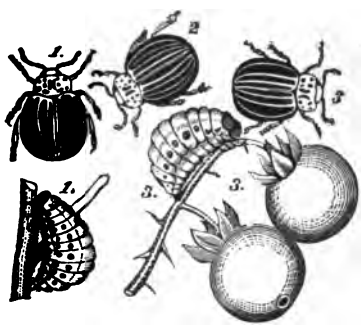
There has been considerable alarm in England, lately, lest the pest should be imported thither in American potatoes, and official investigations have been made in order to determine the advisability of prohibiting importations of the vegetables. The report, however, points out that the larvæ of the parasite are not deposited in the tubers or conveyed by them, and that, with the exercise of proper care, no danger need be apprehended from American potatoes.

Latterly the movements of this pest appear to have been accelerated. Dr. Samuel Lockwood, during the summer of 1874, found potato-vines infested with the larvæ of the genuine Colorado beetle in West Freehold, N. J. The researches which led to the identification of the New-Jersey brood with the formidable Western insect-pest were as follows: Having secured some specimens of the larvæ from West Freehold, Prof. Lockwood placed them in a glass jar with a quantity of potato-leaves. They fed ravenously on these for some time; symptoms of the pupa change were then observed, and, some friable earth having been furnished, the larvæ burrowed into it, and soon assumed the pupa form. In due time the perfect beetle appeared. But, as there are two species of *Doryphora* (*D. decem-lineata* and *D. juncta*), one of which, the *D. juncta* or bogus Colorado beetle, is common in the Atlantic

States, and, as both are very much alike in the beetle form, Dr. Lockwood took every precaution to avoid error in his diagnosis.

In the larva stage the difference between the two species is decisive. Larvæ of the "bogus bug" have on each side the body a row of distinct, round, black spots, while larvæ of the true Colorado species have two rows of these spots on each side of the body. To make assurance doubly sure, Dr. Lockwood procured eggs from the beetles he had himself raised, and had larvæ hatched from them. There was now no room for doubt, for every one of them had the double row of spots. This conclusion is concurred in by Prof. C. V. Riley.

We give here an engraving showing both of the insects just mentioned. Fig. 1 represents the true potato beetle, *doryphora decem-lineata;* Fig. 3, the *doryphora juncta;* and Fig. 2 is an apparent cross between the two, or a variety once found in the South, in which the heavy, thick, black line of the juncta has a very fine yellowish line running partly through it longitudinally.



The capacity of the Colorado beetle for reproduction is amazing. They bear three broods in one season: one female has been known to lay 1,200 eggs. Says the Canadian *Entomologist:* "If the progeny of a single pair were allowed to increase without molestation for one season, the result would amount to over 60,000,000."

In anticipation of this insect reaching Europe from our Atlantic States, the German Government has made thorough preparation to meet it. Prussia has adopted a system of traveling lecturers on agriculture, *Wanderlehrer.* Each *Wanderlehrer* has a district of twenty or thirty miles, and his duties are to visit the farmers personally and instruct them. Specimens of the Colorado beetle have been supplied to these teachers, so that, through their instructions, the German farmers are already well informed as to this insect—in fact, know all about it, and can recognize it when it comes. If such a thing is possible, it will be destroyed on its first appearance. The sad thing is, that

every swarm that moves leaves a permanent colony behind.

Every device has been employed to destroy them. Paris-green has been dusted on the plants. This will kill all it touches. But its application is expensive, and not without danger. It was found necessary to use an ingenious machine, drawn by two horses. This consisted of a large box supported by wheels. The box was open at the top, over which was a revolving flapper, or fan, that brushed the vines over the box, at the same time striking them, thus causing the beetles to fall to the bottom of the box, where was a pair of revolving rollers, between which they were crushed. There were other kinds of machines, but this was the most effective.

In form the Colorada beetle is much like a lady-bug. It has a series of ten stripes on each wing-cover, being alternately brown and yellow. It is a very beautiful insect; but, alas! it is among the most formidable of those diminutive enemies of the industry of man, whose depredations, even in the brief history of our nation, has cost us, in money-loss of crops, more by many times than the sum-total of all our wars. Already, in Maryland, the ravages of the new-comer are filling the farmers with dismay. (77–83)

THE WESTERN GRASSHOPPER PLAGUE.

A LADY correspondent of a Western journal gives the most graphic description we have anywhere seen of the annoyance and discomfort caused by the grasshoppers during their recent invasion of some of the Western States and Territories. Writing from Northeastern Kansas under date of August 5,-1874, the correspondent states that then the grasshoppers were flying all around and alighting on everything, pelting against doors and windows as fast as hailstones ever came. It was scarcely possible to see through a screen-door, on account of the insects swarming on the netting. Out-of-doors, the appearance was as though a severe snow-storm was raging, the wings of the flying grasshoppers looking white, like flakes of snow. "They destroy everything they alight on; every tree and shrub is covered with them. You know we read of Pharaoh's plague, where the insects got into the kneading-trough. I think this is one of them. I went out by the door to try and drive them off, and they flew all over me, and I had to change my dress to get rid of them.. Instead of having rain, we are having showers of grasshoppers. Our six windows are completely covered with them, and as I write they are pouring down the chimney, and coming down the stove-pipe."

TO DESTROY INSECTS.

HOT alum-water is a recent suggestion as an insecticide. It will destroy red and black ants, cockroaches, spiders, chintz bugs, and all the crawling pests which infest our houses. Take two pounds of alum and dissolve it in three or four quarts of boiling water; let it stand on the fire until the alum disappears; then apply it with a brush, while nearly boiling hot, to every joint and crevice in your closets, bedsteads, pantry shelves, and the like. Brush the crevices in the floor of the skirting or mop-boards, if you suspect that they harbor vermin. If, in whitewashing a ceiling, plenty of alum is added to the lime, it will also serve to keep insects at a distance. Cockroaches will flee the paint which has been washed in cool alum-water. Sugar barrels and boxes can be freed from ants by drawing a wide chalk-mark just round the edgeof the top of them. The mark must be unbroken, or they will creep over it, but a continuous chalk-line half an inch in width will set their depredations at naught. Powdered alum or borax will keep the chintz bug at a respectable distance, and travelers should always carry a package of it in their hand bags, to scatter over and under their pillows, in places where they have reason to suspect the presence of such bed-fellows.

MOLES.

M. FLOURENS and other naturalists have experimented with moles to ascertain their habits. It has been fonnd that they will starve to death in presence of abundant vegetable food, refusing to touch it, but that they will greedily devour cutworms, earthworms, mice, and even small birds, when nearly starving in an inclosed jar. Of the birds they only devour the inside; but they devoured, indiscriminately, their own weight each day of snails, insects, larvæ, chrysalides, caterpillars, adders, slow worms, and lizards. M. Carl Vogt relates an instance of a land proprietor in France who destroyed every mole upon his property. The next season his fields were ravaged with cutworms, and his crops totally destroyed. He then purchased moles of his neighbors, and preserved them as his best friends.

A Southern correspondent of the *Scientific American*, having read the above, finds that his experience does not agree with the French:

"I planted some sweet corn in the garden very early last spring and after waiting longer than the proper time for it to come up, I examined it to see what the cause was, and found that a mole had taken every grain in four rows of

corn, across a garden three-fourths of a square acre, not only once, but two more plantings after the first. On the rear end of my farm, in a piece of 'new ground,' they finished half of an eight-acre field. I would like to know what Monsieur Flourens would say to that? The negroes in this section always plant several hills of castor-oil beans in their gardens to keep the moles out."

THE ARMY-WORM.

AN important note on the habits of the army-worm, which is estimated to destroy annually nearly $50,000,000 worth of cotton in the Southern States, is published by Mr. Grote in the *American Naturalist*. This moth was first described and named by Hübner, from Brazil, in 1822, under the name *Aletia argillacea*. Mr. Grote shows that the insect hibernates as a moth, and that it dies out in the central and northern portions of the cotton belt every year, and is replaced the succeeding year by immigration from more southern localities, where the cotton-plant is perennial. The worm never attacks the young cotton-plant in Central Alabama in the spring or early summer, but appears at its earliest at the end of June, and is invariably preceded by flights of the adult moth. Since in Central Alabama insect life becomes active as early as March (and before then the hibernated cotton-moth has disappeared), Mr. Grote asks, "What is the insect doing between that date and July, when the worm appears? and why is the young cotton not attacked in May by the worms from the eggs deposited by the 'hibernating' moths?" If the "hibernating" moths lay eggs, their progeny perish from lack of food. But many chrysalids, he adds, are killed by frost, and there is great irregularity about the completion of the final brood of moths, arising from the age of the insect and the approach of the winter.

POTATO-BUG REMEDY.

REV. F. O. MORRIS thinks that if the rook were introduced into the United States it would have a very positive influence upon the existence and multiplication of insects that are injurious to vegetation, in view of the fact that its large size and semi-domestic habits especially qualify it for attacking such pests, and destroying them on a large scale, as they are said to feed almost exclusively upon insects and their larvæ; and in consequence of their slight degree of shyness they will enter the gardens and orchards freely, and breed in colonies in the trees near country houses.

A SIMPLE INSECT-CATCHING DEVICE.

A WRITER in *Les Mondes* says that he is enabled to materially reduce the number of insects which prey upon the flowers and fruits of his garden, by covering the inside of an old tub with liquid tar, and at twilight putting a lighted lantern within, leaving the whole out over night. The bugs, attracted by the light, try to reach the lantern and are caught and held fast by the tar.

THE NITROGEN OF THE SOIL.

PROF. H. P. ARMSBY observes that, as the necessity of nitrogen to plant-life is universally admitted, it has become an important problem in agricultural chemistry to ascertain the source whence plants derive their supply of that element. Lawes, Gilbert, and Pugh (*Phil. Trans.*, 1861) showed that the cereals, at least, are incapable of assimilating free nitrogen from the air; and this is probably true of all plants. It seems unlikely that the compounds of nitrogen—nitric and nitrous acids and ammonia—existing in the atmosphere, are assimilated, to any appreciable extent, from the air, under natural conditions. It has been abundantly proved, on the other hand, that a fertile soil is capable of supplying vegetation with all needful nitrogen, and we may conclude that it does so. The circumstances of the supply of nitrogen to the soil become, therefore, of the greatest importance to the agriculturist.

It is known that nitrogenous organic substances, such as are in freshly-manured soils, may yield nitrogen in the free state by decomposition, though the particulars of this process are as yet imperfectly ascertained. It has been shown that under some cirumstances organic bodies, such as exist in the soil, are capable of causing free nitrogen so to enter into combination with them as to increase their content of that element. This increase has been generally attributed to the formation of nitric acid from free nitrogen by some oxidizing action.

Deherain has recently shown that tne amount of nitrogen fixed by organic bodies is more than sufficient to have formed nitric or nitrous acid with all the oxygen present. Many details of these experiments, which were numerous and varied, were addnced. The escape of free nitrogen from decomposing animal substances has been fully determined by experiments of Reiset, Lawes, Gilbert and Pugh. There are substantiai reasons for the belief that this results from the oxidation of amide-like bodies in which, the hydrogen being oxidized, the nitrogen is set free.

Prof. E. W. Hilgard made the point that soils must contain clay; without it they were not soil. This clay contains animal matter—the germs of the green spawn and of fresh-water algæ. This is the case throughout the world. The peat bogs are a product of such growth. These germs are among the smallest that exist. They are always ready to start into life, and to start decomposition. Prof. Hilgard claimed priority of discovery in respect to these algæ. Dr. T. C. Hilgard confirmed the observations of his brother, and stated that at the South the transformation of soil by such vegetation is very rapid and evident. (144)

PHOSPHORIC ACID ON OATS.

E. WOLFF describes water culture experiments in which the nourishing solutions, eight in number, supplied graduated quantities of phosphoric acid. The percentage of phosphoric acid in the dry crop varied with the amonut supplied. When this percentage fell below 0.33 (with good field oats it is about 0.44) the amount of straw seriously diminished, but an increase of phosphoric acid above this point did not increase the straw. The corn, however, was greatly affected by an increased supply, and gave by much the largest yield when the phosphoric acid reached 1.11 per cent of the dry crop. The ash of the straw contained no silica, none having been supplied; its percentage of phosphoric acid was 4.4–18.9, that in the ash of field oats (silica deducted) being 9.1. In the ash of the corn, the phosphoric acid varied only from 37.74–3.9 per cent, the percentage in the ash of field oats being 41.3.

OZONE NOT OBTAINED FROM PLANTS.

BY J. BELLUCCI.—By means of a gasometer a current of air was made to pass through a bell-jar covering a pot of living plants, or recently-cut branches or leaves. Before arriving at the jar, the air traversed a glass tube about 60 centimetres long, one-half of which was covered with black paper. A similar tube was connected with the exit-aperture of the jar, and in each of them the usual test-paper for ozone was placed. Various kinds of plants and leaves were used, and two experiments were made in each case. In the first, the uncovered part preceded the covered part, and in the second *vice versa*. All the experiments were made in daylight, and lasted from one to three hours each. In every case the test-paper in the covered part of both tubes was quite unaffected, whereas in the uncovered part the test-paper was colored, and the intensity of the coloration in the two tubes was about the same. It is, therefore, evident that the coloration was

not produced by ozone, but, as M. Cloëz had previously stated, to the complex and simultaneous action of humid oxygen and solar light. (4)

NOVEL WAY OF EXPORTING BONE DUST.

THE immense trade in Australian canned meats, now carried on, has had the effect of causing a great accumulation of bones in Melbourne, Australia, where the putting up is done. The sale of the bones is now growing into a remunerative branch of export trade as bone-dust manure; and an Australian paper, speaking of the subject, gives an account of the manner of its exportation. It says that a recent vessel, bound for London, has on board a shipment of one hundred tons of bone dust, prepared for exportation in an altogether novel manner, and one which promises to come into extensive use. To facilitate this trade, an apparatus has been contrived for compressing bone dust into half its original compass, reducing it at the same time into a form very convenient for shipment. By means of strong pressure the crushed bones are molded into cakes of six inches square and three inches thick, something like flooring-tiles, each cake weighing a little over four pounds. These bone-dust tiles are just adhesive enough to admit of their being handled freely—thrown about like bricks, if necessary—and are yet firm; and when required for use, they can readily be crushed, or melted by the application of a little hot water. A ton weight of the manure measures 26 cubic feet, and contains 252 of the cakes. The manufacture of bone dust for fertilizing is a large and rapidly increasing industry in this country, and this Australian method might be profitably adopted here.

SHELTER FOR MANURE.

A GERMAN agricultural journal has lately published an article upon the protection of manure heaps from rain by roofs, from reasoning based upon observations by Meister. So long as the manure heap is well protected from flowing and stationary surface water, it will receive no injury from ordinary rain-falls.

ARTIFICIAL MANURE.—W. Crookes patents the following method of treatment of waste animal or nitrogenous matters, for the purpose of producing fertilizing substances or artificial manures. Fish, flesh, or other putrescible organized matters, are chopped up or otherwise finely divided, and then steeped in any convenient liquid possessing antiseptic, deodorizing, or disinfectant qualities, or sprinkled over with such a liquid; the liquid portion of the mass is then separated from the solid by means of a hydro-extractor.

MANURES.

J. H. JOHNSON is the author of improved processes relating to the production of manure by the precipitation in a solid and imputrescible form, while retaining its property of assimilation, of the nitrogenous matter contained in solution in blood. The precipitation is effected by means of mineral acid, such as sulphuric or chlorhydric acid; or of compounds such as sulphate of alumina or sulphate of iron, or the two combined; these are mixed with the liquid blood, into which there has been previously introduced a soluble salt or compound, such as an alkaline sulphite or bisulphite, or alkaline earth, or chloride of lime or other hypochlorite, the liberation of one of the constituent elements, say sulphurous acid, or chlorine, by means of the acid subsequently introduced into the liquid effecting by its action complete coagulation. The precipitated matter is collected in a filtering apparatus, and either pressed into the form of cakes or dried. The apparatus consists of two series of vessels through which the blood and acid are respectively conducted to a common vessel below, in which their admixture is effected. These vessels are provided with ball and other cocks for the purpose of obtaining a continuous discharge of the liquids and of intercepting them.

A NEW FERTILIZER.

IN many of the large tallow-rendering factories of Texas and elsewhere, the fatty matter is separated from the bodies of the cattle, after the animal has been skinned, by boiling the entire carcass in a strong tight vessel of large capacity, under steam pressure, until the meat, muscle and offal are thoroughly disintegrated and the bones softened and crumbled. The tallow thus liberated rises to the top of the mass, and is then drawn off from the vessel. In Texas, where animals are slaughtered in immense numbers for the hides and tallow, the residue in the tank being mixed with a large amount of water, and the bones so crumbled that they can not be separated, is thrown away, thus wasting a vast quantity of the most valuable material for fertilizing purposes.

The process below described, which has for its object the utilization of this waste, is susceptible of very extended application, and is based on a peculiar action of plaster (which the inventor claims to have discovered) upon animal matter, in that, when aided by a gentle heat of about 250° Fahr., the plaster entirely absorbs the moisture of the meat and destroys its tendency to recombine therewith. All decomposition, we are informed, is prevented,

while the valuable constituents, most of which, in many processes, are lost through the effect of the high degree of heat necessarily employed, are preserved indefinitely for use.

After the fat has been removed from the tank, the residue is carried to a suitable vessel, and the solid matter allowed to settle. The supernatant liquid is drawn off into another vat and rapidly evaporates by the action of heat to a syrupy consistency. With this is then mixed the solid residue and a quantity of plaster-of-Paris equal to about twenty per cent of original weight of the meat. The mass becomes converted into a friable substance whch can be ground to a fine powder, and which possesses, it is claimed, fertilizing properties equal to good guano. The plaster, beside absorbing the water, the inventor states, fixes the ammonia and nitrogenous elements, and destroys the hydrometric properties of the meat, so that it will keep in any climate for any length of time. The plaster itself is also valuable as a fertilizer.

An analysis of the product made from the waste of rendering tanks, by the chemist of the Agricultural Department at Washington, gives its composition as follows:

Phosphoric acid	6.87 per cent
equal to bone phosphate	15.00 "
Nitrogen	5.11 "
equal to actual ammonia (NH_3)	6.21 "

which is equal to a fair average guano.

Dead animals and the waste of abattoirs, by simply hashing them, by means of a powerful machine, with a small proportion of plaster-of-Paris, may thus be advantageously utilized, and would produce a fertilizer richer in manurial constituents than that shown in the above analysis. The cost of manufacture is said to be very small. H. Stevens, Brazoria, Texas, is the author of this process.

ANIMAL MANURE.—Renoult patents the following processes for solid substances. A solution is made consisting of

Sulphuric acid at 66° B	1 part.
Water	2 parts.

100 parts of the animal solids (flesh, fish, etc.) are treated with 18 of the acid, the solids having previously been chopped up small, and the whole being mechanically mixed together, and ground up for one hour: the whole is then allowed to stand for about 6 hours, and finally treated with 8 per cent of finely-pulverized quicklime; sulphate of lime is thus formed, in which the animal matter remains inclosed; after standing for 6 hours, the whole is molded into brick-shaped masses, which are drained in the per-

forated molds in which they are prepared, and then dried and pulverized; the liquid portion is evaporated in the water bath, and then mixed with the pulverized brick masses.

Liquid and semi-liquid masses like brains or blood are treated with 9 per cent of sulphuric acid at 66°, and 12 per cent of quicklime, the rest of the process being the same. (22)

IS YOUR LAND POOR?—If so, it is because it lacks either phosphoric acid, potash, lime, soda, or nitrogen, or perhaps all of these. The other six minerals required by plants as food are generally found in the soil in sufficient quantities to supply the plants, while the soil is generally lacking in those named above, and which are indispensable to their growth and vigor. And in proportion as you supply the deficient article to your poor land, so you add to the health and vigor of the plants, enabling them to draw a large proportion of their food from the air, and thereby increasing your crops nearly three to one.

LIME-SOILS AND THE POTATO-ROT.

A WRITER in the *Chemical News* is led by analysis of diseased and sound potato-tubers, to ascribe the potato-rot to a deficiency of lime and magnesia in the soil. Different observers state the percentage of magnesia in the ash of sound tubers at from five to ten per cent; in the diseased tubers analyzed by the author it was only 3.94 per cent. Analysis of sound tubers shows over five per cent of lime, but in the ash of diseased tubers the author found only 1.77 per cent. A similar observation was made some years ago by Prof. Thorp with regard to diseased and healthy orange-trees; in the former there was a deficiency of lime and magnesia.

It was shown, by the late Dr. Crace Calvert, that lime is one of the few known substances that are capable of altogether preventing the development of fungi in organic solutions. He does not give any experiments relating to the action of caustic magnesia on fungi; but doubtless that action will be found to be similar.

"Here, then," observes the author, "is a curious and significant fact. Diseased potatoes are deficient in lime-salts, and lime prevents the development of fungi. May not the development of fungi in the vessels of plants be furthered by this deficiency? The circumstances are such as scarcely to leave room for doubt. So far, then, theory and practice agree: lime has been found by experience to be useful in preventing the disease, and it is likely that magnesia will be found to have a similar effect."

NEW METHOD FOR POTATOES.

MR. SHIRLEY HIBBERD lately read before the Society of Arts, London, an account of his new method of cultivating potatoes, whereby, he alleges, the rot is entirely prevented. The plan consists in placing roof tiles on the level surface of the ground, in rows four feet apart. The potato cuttings are placed on the convex surface of the tiles, and earth from between the rows is molded up over the cuttings. The roots are thus always kept drained, and the plants have plenty of air. This plan reminds us of that of Comstock, who used to go about selling the secret of raising potatoes without rot and increasing the yield. He planted the tubers on the surface of the ground, covered with leaves and twigs, with a light covering over them of earth. The Hibberd system is alleged greatly to increase the yield of potatoes.

NEW FODDER PLANT.

A NEW fodder plant, the *Symphitum caucasium* (Caucasian comfrey), is exciting a great deal of attention in Europe, particularly in England.

The first authorities confirm accounts of crops fabulously large, and it is said that this must soon replace most other fodder plants.

THE ECONOMY OF BEER.

PROF. MAX VON PETTENKOFER, the eminent Munich chemist, states that, to make a quart of good beer, there is required, at least, a pint of good barley, beside hops, etc. The product contains not a single trace of albumen, and only a very small percentage of alimentary principles: in short, it is only a *condiment*, not a food-stuff, properly so-called. The question now arises, Would it not be better to send this barley to the mill, and make of it a bread-stuff, instead of brewing from it a costly beverage, which contributes little or nothing to the system? Or, better still, Would it not be advisable to grow, in place of barley and hops, wheat and rye, either of which would give better bread than barley?

Prof. Pettenkofer holds that the need of mere condiments is no less imperative than the need of food-stuffs, properly so-called. "Butter and cheese," he says, "are neither as good nor as complete food-stuffs as milk, and yet butter and cheese are made, and will continue to be made, even though it were possible to transport milk in good condition to considerable distances." The same is to be said of barley and beer. Prof. Pettenkofer observes that the consumption of beer is steadily increasing, in spite of the advance in prices, and he is con-

vinced that this state of things will continue, no matter what weight of argument may be brought against it. "Condiments of this kind," he says, "are often, no doubt, the occasion of real waste, but yet the majority of mankind can always, to their great profit, find, by observation and self-control, the proper amount of them to consume."

CHICORY IN GROUND COFFEE.

A PRELIMINARY examination of coffee for admixture is best made by gently strewing the powder upon the surface of cold water. The oil contained in coffee prevents the particles from being readily wetted by the water, thus causing them to float. Chicory, burnt sugar, etc., contain no oil, and their caramel is very quickly extracted by the water, with production of a brown color, while the particles themselves rapidly sink to the bottom of the water. On stirring the liquid, coffee becomes tolerably uniformly diffused without sensibly coloring the water, while chicory and other sweet roots quickly give a dark-brown turbid infusion. Roasted cereals do not give so distinct a color.

VALUE OF OATMEAL AS A FOOD

OATMEAL consists of—

Water.	Fat.	Starch.	Nitrogenous matter.	Mineral matter.	Cellulose and loss.		
8.7	7.5	64.0	11.7	1.5	7.6	=	100

It contains 2 per cent N., while wheat, according to Payen, contains 1.64 per cent, rye 1.75 per cent, and rice 1.08 per cent. Boussingault found in oatmeal 0.0131 per cent iron, contrasting with 0.0048 per cent in flesh and wheaten bread. It is probably, therefore, more nourishing than the flour of other species of grain.

AN EDIBLE LIZARD.—Dr. Burt G. Wilder communicates to the *American Naturalist* a brief note on the *Menobranchus Maculatus* as an article of food. This animal he regards as probably a variety of the banded Proteus, or big water-lizard, but it is never striped, and always spotted. So abundant are they in Cayuga Lake that a single fisherman brought him a hundred of them during the month of March. The animal is held to be poisonous, and the fishermen dislike even to touch them. So far, however, is this from being the case, that they are absolutely harmless in every way. Dr. Wilder and his associate, Dr. Barnard, have eaten one which was cooked, and found it excellent. It is their intention to recommend the *Menobranchus* for food, but not until all their investigations into the anatomy and embryology of the animal are concluded.

NEW MEAT-PRESERVING PROCESS.

M. SACC has obtained excellent results by using acetate of soda in powdered form. The meat is placed in a barrel and the acetate placed in, when it is left for forty-eight hours. Thus prepared, the meat, it is said, will keep for any length of time, and may be prepared for cooking by soaking for 12 hours in water, to every quart of which a quarter of an ounce of sal-ammoniac is added.

PREPARATION OF PRESSED YEAST. BY J. B. DIVIS.—Ordinary beer-yeast is stirred up with cold water, in which a small quantity of carbonate of ammonia has been dissolved. It is then allowed to settle, drained, washed, and pressed into cakes, to which a little starch and ground malt is added. Some kinds of yeast settle with difficulty. In such case, ice-cold water in larger quantity may be employed, or a little alum may be added to the first water, which must be completely removed by washing.

SAUSAGES COLORED BY ANILINE.—Aniline red is used to impart to sausages a fresh and healthy appearance. It can easily be detected by the use of alcohol or ether, either of which substances dissolves aniline, but not blood. The use of aniline red is severely reprehensible, not only from the fact that it is known to have caused the illness of entire families who have eaten meat colored with it, but also because, from its mode of preparation, it frequently contains arsenic, and must, therefore, act as a poison.

DEATH OF TREES IN CITIES.

AT a recent meeting of the Scientific Committee of the Royal Horticultural Society, Dr. Voelker stated the results of his investigation of the soil of a London square in which Messrs. Veitch had twice planted trees, which in each case had died. On examining the clear watery solution from treating the soil with distilled water, he found that the soil contains one-tenth per cent. of common salt and two-tenths per cent. of nitrates. Whenever the amount of chlorine in soil reaches anything like an appreciable quantity, it exercises an injurious influence. Land, for example, which has been inundated by the sea, will not grow wheat for the next two years, though in the first year cabbages may be grown. The quantity of nitrates in the soil sent to him was remarkable. Usually in a soil it did not reach a proportion which could be expressed otherwise than by a third place of decimals. He could not doubt that the two saline ingredients mentioned did the mischief.—*Builder.*

THE SNOW-PLANT.

A VERY fine specimen of the snow-plant of the Sierra—the *Sarcodes sanguinea* of Torrey—was lately brought to San Francisco. It was twenty-nine inches in length, inclusive of the root stem; the spike of flowers measuring over sixteen inches, and containing ninety-eight blooms. This lovely plant is one of the ornaments of our Sierra, being found only at an elevation of about 4,000 feet; and it is a matter of regret that, owing to the fact of its being parasitic in its habits, all attempts to cultivate it have hitherto failed. It is much sought after by the deer, its succulent stem being a favorite article of food with these animals. (113)

TREE-PLANTING IN TOWNS.

MR. WILLIAM SUTHERLAND gives some directions about planting trees in the streets of towns and cities. What is most wanted, says he, is a tree easy to move, of rapid growth, and not liable to injury from the effects of gas or the action of worms. The tulip poplar has been found to be perfectly proof against the ravages of worms. All trees suffer more or less from the effects of a gas leak near their roots, though some kinds are less injured by this cause than others. Hundreds of trees die annually from the effects of gas alone, while others die for want of nourishment, being planted on sidewalks that have been graded up with coal ashes and other refuse, without sufficient soil being put in to support them; they grow a little at first, and then gradually fail. While the tulip poplar is a fast grower, and invulnerable to worms, it is one of the worst trees to move. The same is to be said of the cucumber tree (*Magnolia acuminata*). The lindens are fine trees, of rapid growth, and easily moved, but among the first to be attacked by insects; and the same may be said of the maples. The white, red, and yellow-flowering horse-chestnuts, and the Norway maple, are fine trees, need very little pruning, and are only occasionally attacked by insects; but they are of slow growth. The poplar and paper mulberry are noble trees, but do not root deeply, and hence throw up the pavement and blow over. The offensive odor of the blossoms of the ailanthus makes that tree undesirable. The author judges the black or Carolina poplar to be the best tree for city streets. It is easy to move, of rapid growth, not generally troubled by insects, and not readily affected by gas. The leaves are of a dark, glossy green, and of good size, affording ample shade. If the tree be healthy and properly planted, with a cart-load of good, fresh earth, success is almost certain. Next in order come the Norway maple and horse-chestnut.

TREE-PLANTING IN NEBRASKA.

THERE is something impressive, even poetical, in the way Nebraska is working out the problem of how to cover her broad lands with trees. Some years ago Hon. J. Sterling Morton, of Otoe county, conceived the idea of making tree-planting a kind of holiday, uniting work with pleasure. This gentleman founded what is called in Nebraska, Arbor Day. On the second Wednesday of each April every farmer throughout the State was requested to plant a single tree at least, or as many more as he felt inclined to. On the first Arbor Day of 1871 two millions of trees were planted. This year the State Board of Agriculture indorsed the original plan, and have even recommended that the day be made a legal holiday. Each owner of land is recommended to plant his tree, and the State Board has agreed to award a prize to the person planting the largest number. One industrious man took the prize this year, having set out no less than 27,800 trees. Dr. Holmes once told a strange story of how all the world agreed to shout out at the same time, in order that the people in the moon might hear it. As the hearing power of the inhabitants of any other planet might not be as sensitive as their seeing faculties, perhaps in time Nebraska, all covered with forests, may show to other worlds a physical aspect of a novel character. But jesting aside, if only this experiment could be carried through for a limited series of years, we might find that certain modifications of climate most beneficial to man and agriculture would take place. There is something very grand, even noble, in a people devoting a portion of their time and energy to producing a growth of timber, which, if it benefits them in their life-time but very little, may be of incalculable advantage to generations coming after them. People in Nebraska are striking a balance with the future. It would not be amiss if the dwellers in the older States, imitating younger Nebraska, should institute Arbor Days.

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PEAR-CULTURE.

A WRITER in the *Gardener's Monthly* observes that pears have a tendency to crack when the trees stand in soil which is deficient in lime and potash. Common wood ashes contain these salts nearly in the proportions that pear trees on such soil require—40 per cent. of potash and 30 per cent of lime. Reasoning from these facts, the author applied wood ashes at the rate of four hundred bushels to the acre, after the fruit had formed and cracked. Many of them healed up and made perfect fruit. The disease was totally eradicated by the next season.

AMERICAN GRAPE-VINES IN FRANCE.

DETAILS have been recently published of the experiments conducted in the planting of American vines—Clinton, Ives' Seedling, and others—by M. Borty, at Raqueman, in one of the divisions of France most infested with the phyllaxera. The success of the experiment has been complete, the vines, after a trial of ten years, flourishing where the French varieties have failed.

VALUE OF SMALL BIRDS.

IN a paper read before the Paris Société d'Acclimatation, Dr. Turrel suggests that the rapid spread of the *Phylloxera vastatrix* in France may be due to the scarcity of small birds in that country. Forty years ago, he says, linnets, tits, etc., were numerous in Provence, and in the autumn they could be seen posted on the vine branches, carrying on a vigorous search after the insects, and larvæ and eggs of insects, concealed in the cracks of the stem and leaves of the plant. Since the commencement of the present century, however, it is easy to perceive that the destruction of small birds has been carried on more and more generally; and that, concurrently with this war of extermination against the feathered tribes, the numbers of destructive insects have increased at an alarming rate. Dr. Turrel thinks that, though it can not be absolutely maintained that the oidium and the Phylloxera, the two latest forms of vine disease (the one a vegetable, the other an insect parasite), owe their frightful extension to the scarcity of small birds, yet it is unquestionable that a plant like the vine, weakened by the attacks of insects, is less in a condition to withstand the ravages of parasites; and that, deprived of its feathered protectors and left to the successive and unchecked onslaught of the vine grub and other normal enemies, it has been predisposed to succumb before the ravages of its new enemies. The obvious moral is that the French are themselves partly to blame for their indiscretion in killing the useful small birds.

QUAIL-BREEDING IN THE CITY.

THE birds are inclosed in a large galvanized iron frame running all the length of the yard, wherein is planted small pines, flowers, etc., so as to give the birds cover and hiding-places when they hatch. These quail are now breeding in the yard of a gentleman field sportsman who has been amusing himself for the last three years in trying the experiment of breeding quail in New-York city. He has succeeded in raising large broods for two seasons, and bids fair to add a third term to his success.

QUAIL FOOD.—A farmer's boy in Ohio, observing a small flock of quails in his father's corn-field, resolved to watch their motions. They pursued a very regular course in their foraging, commencing on one side of the field, taking about five rows, and following them uniformly to the opposite end, returning in the same manner over the next five rows. They continued in this course until they had explored the greater portion of the field. The lad, suspicious that they were pulling up the corn, fired into the flock, killing one of them, and then proceeded to examine the ground. In the whole space over which they had traveled he found but one stalk of corn disturbed. This was nearly scratched out of the ground, but the kernel still adhered to it. In the craw of the quail he found one cut-worm, twenty-one striped vine bugs, and one hundred chinch bugs, but not a single kernel of corn.

THE TURBIT.

THE TURBIT.

THE shouldered variety shown in our engraving is one of the prettiest of our fancy pigeons, and commands the admiration of all at first sight. It is small, neat, and elegant in appearance; rather short; chest broad and full; active and interesting; good breeders; and can be had in a great variety of colorings; which, in the shouldered

birds, gives a pleasing contrast and beauty of plumage peculiar to this variety of pigeons.

The head of the Turbit is quite peculiar, and differs from any other variety of pigeons except the owl, which it somewhat resembles. The head should be broad, full, and short, while the top should be somewhat flat. The beak should be white, broad at the base, like that of a good owl; but perfectly straight, and can not be too short.

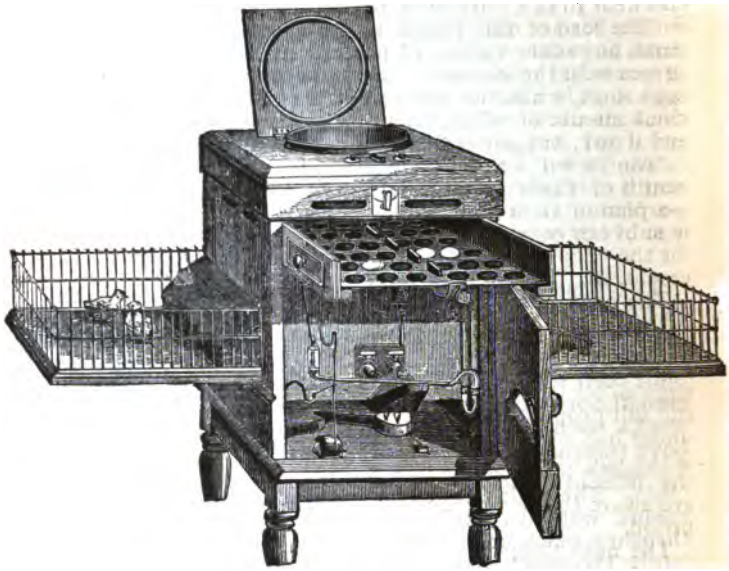
The Turbit is thought by many to be a native of the south of France, as it is said to be found there in greater perfection than elsewhere. Germany also claims it as one of her own production.

IMPORTED SINGING BIRDS.

THE Cincinnati Society of Acclimation still continues its good work. In the winter of 1872–3 it received a large shipment of birds from Europe, and set them at liberty in the spring of last year. Of these birds, several species built their nests last summer in the neighborhood of Cincinnati, some stayed all the winter, and within the last four weeks even such as left their breeding-places last fall have returned. The present year will show whether these European birds can be introduced into the good State of Ohio. The birds set at liberty consisted of red-breasted robins, wagtails, skylarks, starlings, dunnocks, singing thrushes, blackbirds, red-wings and nightingales. Quite lately, the agent having arrived from Europe, the following additions were made: Goldfinches, siskins, great tits, Dutch tits, dippers, Hungarian thrushes, bullfinches, cherry-birds, nestel thrushes, corn-crakes, crossbills, etc. Some $8,000 has so far been expended by the society. The main object of the association is to foster the introduction of foreign useful insect-eating and singing birds, and to urge proper legislation for their preservation.

There is something exceedingly beautiful in the idea of citizens of foreign birth being desirous of surrounding themselves with the most pleasing associations of their mother country, and as the conception is a German one, it redounds to their credit. If it was considered among the old Romans and Greeks, as pleasing to the gods to give liberty to caged birds, there still remains in the present race of men, some thousands of years older, this same kindly touch of nature. It would be pleasant for us to record that similar associations were being organized in other States. The President of the association, A. Erkinbrecher, Esq., with the Secretary, A. Tenner, Esq., state their willingness to give all information to those proposing to introduce foreign birds into the United States.

ARTIFICIAL INCUBATION.



BOYLE'S EGG-HATCHING MACHINE.

OUR engraving shows an incubating machine, invented by Mr. Boyle, of London, England, designed for use in connection with gas. It is so constructed that when once set to any degree of heat within the limits of 40° and 200° Fahrenheit, it will maintain the same for any length of time without variation. It is adapted to the control of hot-water pipes in hot-houses, or any other place; to the opening and shutting of stove-dampers; and, in fact, to any use which requires a simple up-and-down motion in connection with heat.

It is intended to act perfectly untouched for an indefinite time, and there will be no perceptible variation in the heat.

The heat for an incubator is 106°. The hen does not impart 106°to the egg. The egg will always be found, if broken under a thermometer, to be 104°, and the under side of the egg will be considerably cooler than the upper; and experience shows that at 106° constant heat (the heat of the hen) the eggs will die either before or on chipping the shell, while at 108° constant heat they die at once. These data are given from many experiments.

It has been observed that nests made under the hedg-

es, or in any wild situation, produce more and stronger chickens than those cared for in baskets or boxes. Under the former circumstances the under side of the egg must be much colder than the upper side. And this agrees with the inventor's experience, who finds that in eggs kept in a steady temperature, equal on all sides, the chickens usually die on the nineteenth or twentieth day, and if any struggle out they are very feeble. In the incubator it will be seen that this natural irregularity of heat is carefully imitated. Heating the egg from beneath —a plan often tried because of its great facility—is directly subversive of the natural conditions. The receptacle for the eggs in this incubator imitates all the conditions essential.

The next point for consideration in imitating Nature is the daily cooling of the eggs for about twenty minutes, rather more than less, when the hen leaves to feed. This must by no means be omitted, and we do not think that eggs suffer from a great deal of cooling (so that they get the full proper heat between times); but they soon die under half measures, such as many hours at 100° or 90°. If the eggs be never cooled, most of them will die between the fifteenth and twentieth day, and all farmers' wives are aware that a "hard sitter" does not produce a certain brood.

The next thing to imitate is the natural damping of the eggs by the ground, the air, and slightly by the perspiration of the hen. This must be attended to, for if it be attempted to hatch the eggs without any moisture the chickens will in most cases be found to hatch without absorbing the yolk-bag, or, having partially absorbed it. will, on moving about, again extrude the bag and perish, On the other hand, with too much moisture, the eggs will addle. Daily sponging of the eggs is generally recommended, but the inventor prefers a gentle natural vapor.

Finally, as the hen kicks her eggs about regularly on returning every day to the nest, it must be for the benefit of the chicken, and therefore it should be imitated. When the chickens chip the egg, the hen sits lightly, and lets the little prisoners extricate themselves, if they are, as they ought to be, strong enough. She never, as it has been asserted, attempts to help them. Moreover, her instincts no doubt tell her, that if a chicken can not escape, it is not strong enough to live when assisted. In this incubator a chamber is provided in which the egg is placed when chipped, or immediately before chipping, and the chicken then comes out in freedom.

The hen covers the chickens for some weeks under her breast and wings. To imitate this most essential comfort

two "mothers" are provided, heated by the cistern, and the chickens are placed under them as soon as dry. The mothers must be supplied with cotton wool or flannel for the chickens to nestle in, and with the warmth against their backs they are quite contented.

This incubator holds thirty eggs at a sitting, or three chickens every two days; but it can be made to hold double or treble, if specially ordered.

NOVEL MODE OF SLAUGHTERING CATTLE.

THE present mode of killing cattle, by striking the animal with a hatchet or axe, is a cruel operation, as in most cases repeated blows are required to produce the death of the animal. Different methods have been recommended and tested for the purpose of executing the operation with the greatest possible dispatch, so that the animal be not unnecessarily exposed to protracted suffering. The device represented in the illustration is a French in-

vention, and promises to meet all requirements, being so simple in construction that it may be readily employed anywhere. The head of the animal is covered by a kind of mask of suitable material, which closes the eyes entirely, and is at the centre provided with a circular plate of sheet iron, riveted thereto, which guides in a central perforation a strong steel bolt or pin, in a direction vertical to the plate. The inner end of the sliding-bolt faces the head of the animal and is made hollow, while the outer projecting part is provided with a large knob. The masked or blindfolded animal has no idea of his fate, a single blow of the hammer or club on the knob being sufficient to drive the bolt into the brain, and produce the instant dropping of the animal as if struck by lightning. The theory is, that the small quantity of air in the hollow end of the bolt is forced with the same into the brain, and, being heated by the compression, exerts a pressure on the brain, and causes thereby almost instantaneous death. The whole operation is completed within half a minute. Several cities of Germany and France have provided by special ordinances for the introduction of this device, which recommends itself to the attention of all humane persons.

A NEW USE FOR CHICKEN FEATHERS.

CHICKEN feathers are among those waste products of the farm of which no regular means of utilization has heretofore been suggested. Myriads of them are strewn over the barn-yard, packed into the floor of the chicken-house, or are converted into positive nuisances by the wind, which bestrews them over lawns and flower-beds, or drives them into open doors and windows. The down alone is, we believe, occasionally used as a stuffing for pillows or cushions, and sometimes employed as an adulteration in goose feathers; but the long plumes of the wings, sides, and tail of the bird, unless made into rude bundles to serve as dusters for the housewife, are generally regarded as totally worthless.

"According to statistics very carefully compiled," says a writer in *La Nature*, "we throw away yearly a quantity of chicken feathers, the intrinsic value of which is equal to the money which we pay out for cotton." A startling statement, but the author considers it true; and he proceeds to explain how the feathers are prepared to render them valuable: The operation is to cut the plume portions of the feathers from the stem, by means of ordinary hand scissors. The former are placed in quantities in a coarse bag, which, when full, is closed and subjected to a thorough kneading with the hands. At the end of five minutes, the feathers, it is stated, become disaggregated and felted together, forming a down, perfectly homogene-

ous and of great lightness. It is even lighter than natural eider down, because the latter contains the ribs of the feathers, which give extra weight. The material thus prepared is worth, and readily sells in Paris for, about two dollars a pound. About 1.6 troy ounces of this down can be obtained from the feathers of an ordinary-sized pullet; and this, on the above valuation, is worth about 20 cents. It is suggested that, through the winter, children might collect all the feathers about a farm, and cut the ribs out as we have stated. By the spring-time a large quantity of down would be prepared, which could be disposed of to upholsterers, or employed for domestic uses. Goose feathers may be treated in a similar manner, and thus two-thirds of the product of the bird utilized, instead of only about one-fifth, as is at present the case.

The chicken down is said to form a beautiful cloth when woven. For about a square yard of the material, a pound and a half of down is required. The fabric is said to be almost indestructible, as, in place of fraying or wearing out at folds, it only seems to felt the tighter. It takes dye readily, and is thoroughly water-proof. There appears to be a good opportunity here for some ingenious person to invent machines to cut and treat the feathers.

TEMPERATURE FOR THE SEEDS.

F. HABERLANDT has prepared a table showing the approximate minimum temperature at which a large number of agricultural seeds will germinate. The minimum for by far the largest number, including wheat, barley, rye, oats, buckwheat, sugar-beets, linseed, poppy, clover, lucern, peas, rape, mustard, etc., is below 3.8° R. The minimum for sainfoin, pimpinella, carrot, cumin, sunflower, cat's-tail grass, *Sorghum sacchar*, *Sorghum vulgare*, and maize, is between 3.8° and 8.4° R.; for tobacco and gourd between 8.4° and 12.5° R.; and for cucumber and melon the minimum lies between 12.5° and 14.8° R. A table is also given showing the percentage of seeds germinating at the temperatures 13°, 20°, 25°, 30°, 35°, and 40° R., and the number of hours elapsing before the rootlets reached a length of 2 mm. The maximum limit for gold-of-pleasure, coriander, and marjoram is between 20° and 25° R.; for wheat, rye, barley, oats, English ray-grass, vetches, horse-bean, peas, chick-peas, white mustard, woad cabbage, late kohlrabi, turnip, radish, madder, fennel carrot, cumin, parsley, poppy, linseed, tobacco, and aniseed, between 25° and 30° R.; for the common bean, lupin, clover, lucern, early kohlrabi, summer rape, buckwheat, chicory, sunflower, spurry, and some varieties of cabbage, between 30° and 35° R.; and, finally, for maize, *Sorghum vulg.*, pa-

nic grass, turnip-radish, hemp, teasel, gourd, cucumber, and sugar-melon, between 35° and 40° is the maximum. A third table is given showing the average growth of the rootlets in two days at different temperatures. In all cases there is increased growth from 13° to 20° R.; in many cases, as grasses, clover, mustard, and linseed, a decrease from 20° to 25° R., and in nearly all cases a decrease from 25° to 30° R. The maximum limits obtained by the author are generally rather lower than those of Sachs, probably owing to the superiority of the author's apparatus.

DOMESTICATION OF THE ZEBRA.

FOR many years the zebra has been considered as absolutely untamable, but one or two instances of the contrary being recorded, and considered as remarkable exceptions to the general rule. The Acclimatization Society of Paris has experimented, with a view to determine whether their taming was actually possible or not.

A number of extremely vicious zebras were secured. At first they were entirely unmanageable, but became more docile after horses were kept with them for some time. Since then they have been readily harnessed, and are found to work steadily and well. The Bulletin of the society now announces that there is no question as to the possibility of domesticating the zebra, if treated kindly, and that they can be usefully employed for draught animals, having great endurance and vigor, and occupying a position between the horse and the ass, but in all essential respects corresponding with the latter animal.

TRAINING SHEPHERD-DOGS.

SHEEP-RAISERS in California have an ingenious system for training dogs to guard their flocks. In Southern California one may wander for miles, and see thousands of sheep without a single shepherd to watch them, but around each flock half a dozen dogs. These have the entire care of the sheep, drive them out to pasture in the morning, keep them from straying during the day, and bring them home at night. These animals have inherited a talent for keeping sheep, and this talent is cultivated in the following way: When a lamb is born, or the shepherds have a pup which they want to train, the lamb is taken from its mother, she not being allowed to see her offspring, and the puppy is put in its place, and the sheep suckles it. When the puppy grows old enough to eat meat, it is fed in the morning, and sent out with the sheep. It stays with them, because it is accustomed to be with its foster-mother; but it can not feed with them, and,

as they get full, the dog grows hungry. At length, impatient to return, in hopes to get its meat, the dog begins to tease and worry the mother, and finally starts her towards home; the others follow, and thus the whole flock is brought in. If they are brought home too early, or the dog comes without them, he gets punished in some way; and thus, by taking advantage of their instincts and appetite, these dogs are trained to a great state of perfectness, and become invaluable to the owners of large flocks.

IMPROVED DRIVING REIN.

STILLMAN E. MATHEWS, Chaska, Minn.—This invention consists of reins or a cord connected to them, arranged through the bit ring, around the bit and under the under jaw, from one side to the other, so that the strain tends to gripe the jaw very firmly between the bit and the part passing under the jaw. By this means a powerful effect is produced on the horse, greatly interfering with his running. It is also proposed to connect the reins to the bit-ring by other safety straps, to come into action in case the aforesaid cord breaks.

SPONTANEOUS COMBUSTION OF HAY.

H. RANKE has had an opportunity of confirming Büchner's theory that, after the evaporation of the greater part of the moisture, in consequence of the heat developed by the spontaneous decomposition of moist hay, a kind of carbonization takes place, giving rise to a pyrophoric carbon, which takes fire in contact with oxygen.

The stalks of grass in the case seen by the author retained their structure, but showed the properties of true carbon, and made a black mark on paper. If hay is heated in an oil-bath up to 300°, the same phenomenon takes place.

GRASSING A SLOPE.

A STEEP slope may be grassed over without sodding by first smoothing the surface and then mixing a tough paste or mortar of clay, loam, and horse manure, with sufficient water. The grass seed, which should be a mixture of Kentucky blue grass and white clover, should be thickly but evenly scattered upon the moist surface of this plaster, as it is spread upon the bank. The plaster should be at least one or two inches thick, and a thin layer should be laid over the seed. The surface should be kept moist, and a light dressing of some active fertilizer would help the growth. In a few weeks the growing grass should be cut, and should be kept short at all times until a thick sod is formed.

PATENT CALF-FEEDER.

IN these days, when the successful rearing of cattle is an important item of farm management, a wide difference may be seen in the appearance of two calves—one fed by a pains-taking hand, and the other allowed to gulp down its food without time for admixture with the saliva. This is a very important matter, seeing that success or failure frequently depends upon it. Of course, the nearer the process of feeding is approximated to the slow natural action of sucking, the better for the young animal. The implement shown in our illustration, if properly cleaned from time to time, feeds in the most natural manner, and renders it impossible for the calf to gorge itself. It is a vessel of galvanized iron, shaped like a milk-can, having upright sides and concave bottom, with an iron bale handle and a splayed hoop foot, which causes it to stand firmly on the ground. Midway in the vessel is a fixed ledge, into which a self-locking cover closely fits. This cover has a vulcanized india-rubber teat, fixed in its centre and communicating with an india-rubber tube extending to the bottom of the vessel, the concave nature of which allows of the calf making a clean meal. The vessel holds about five quarts, and can be readily cleaned by removing the cover. The new feeder entirely dispenses with the unpleasant and dangerous practice of feeding with the finger, and the food is not so liable to be wasted.

INDIA-RUBBER SHOES FOR HORSES.

WE can describe this invention in no better or more concise terms than by stating that it is an india-rubber overshoe for horses. It is made and lined in precisely similar manner to the articles of apparel worn by the human race, and, in fact, presents no points of difference save in its shape and its manufacture from the best quality of india-rubber.

It is designed as a substitute for the iron shoe, and as a means of preventing the many maladies to which horses' feet are subject. The inventor informs us that horses suffering with cracked or contracted hoof, and similar painful hurts, are quickly cured by the substitution of the rubber covering for the unyielding metal shoe. The elasticity of the former allows the hoof to remain in its natu-

ral shape, while protected from abrasion against pavements by the heavy rubber sole beneath.

The device is easily removed from or put on the hoof, and hence, while standing in the stall or turned out to pasture, the horse may be left barefooted. In winter-time the covering serves as a protection against illness due to the common practice of mingling salt with the ice and snow in city streets, while the roughened surface of the rubber beneath serves to give the animal a foot-hold in slippery weather.

As compared with iron shoes, the cost of the rubber ones is about one-third more, and their weight is some 40 per cent less. Sixteen sizes are manufactured, so that accurate fits may be obtained. With reference to wear, the inventor states that the durability, owing to the fine quality of rubber employed, is very great. The device has been successfully used for some time past, and, we understand, has received the indorsement of the New-York Society for the Prevention of Cruelty to Animals. (83)

EMULSION OF BUTTER.

A. SCHISCHKOFF shook up butter with warm milk for a long time, and obtained a liquid which in appearance and properties resembled fresh milk, and on standing deposited a layer of cream. This cream, on proper treatment, gave butter which could not be distinguished from ordinary butter. The milk globules of fresh milk remain fluid for a long time, and at relatively low temperatures; agitation, lowering of the temperature, and an acid reaction produce the solid form.

CAUSE OF THE CUD.

M. TOUSSAINT, in studying the cause of the regurgitation of the food in the process of rumination, thinks that he has demonstrated that the food, mixed with a great quantity of liquid, ascends to the mouth during rumination by the effects of atmospheric pressure.

TO RENDER TOUGH MEAT TENDER.—G. C. Roy states that Indian cooks are in the habit of adding to tough meat a few drops of the milky juice of *Carica Papya*, whereby the meat is rendered tender. From experiments made on the subject, it seems that the juice exerts a marked disintegrating power on animal matter without promoting putrefaction. Not impossibly the active agent is an albuminous ferment analogous to yeast. The meat does not seem to be rendered injurious to health, as the meat experimented with was repeatedly eaten by a cat without injury. (2)

MATERIA MEDICA, THERAPEUTICS, HYGIENE.

SKIN GRAFTING.

THE operation of skin grafting, says Dr. R. J. Levis, of the Pennsylvania Hospital, is now conclusively accepted as one of the resources of surgery.

The utility of the transplantation of minute pieces of skin to granulating surfaces has been demonstrated in a vast number of instances. It is admitted that, by creating centres of eccentric cicatrization on extensively ulcerated surfaces, the rapidity of the healing process can be much increased. Ulcers of a chronic character, which have obstinately resisted cicatrization in a concentric direction, can be healed by the ingrafting of new centres of germination in the midst of the areas of ulceration. Experience has also shown that the procedure is applicable to plastic surgery in facilitating the cicatrization of surfaces denuded by gaping in the division of cicatrices, and in the sliding of flaps of integument.

Besides the increase in the rapidity of healing, due to extending the lines of cicatrizing edges, a decided and important physiological influence is exerted by the presence of the grafts on ulcerated surfaces. The surface of an indolent ulcer seems to be stimulated to renewed vital action, and the increased healing impulse even influences to active germination the peripheral limits of an ulcer in which granulation has long entirely ceased.

The utility of skin grafting has, in my observation, been in no instances more demonstratively shown than in cases of extensive denudation caused by destruction of skin, as in burns, and loss of large areas of integument from traumatic injuries. In the case of a man whose back was extensively charred at a lime kiln, while lying under the toxic influence of its emanations, the sloughing integument having left an immense area of ulceration over his dorsal and lumbar regions, the successful ingrafting of numerous minute pieces of skin healed the vast ulcer with astonishing rapidity. In an instance of the entire loss of the skin of a leg, caused by deeply burning with coal oil, which had filled a shoe and saturated a stocking, the healing process was by the same procedure rendered as surprising and satisfactory.

It seems now probable that amputation, which, as a final resource, is by surgical authority justified in certain cases of extensive ulcers of the leg which all expedients

have failed to heal, may be substituted by the simple device of skin grafting.

All of the conditions essential to successful skin grafting I have not, after extended observations, fully determined. The most favorable condition for the development of the grafts is certainly that of healthy, active granulation of an ulcer; and the more nearly this state is approached, the greater, as a rule, will be the success.

One of the beneficial claims for skin grafting is with reference to the avoidance of the eventual contraction which disfigures, deforms, and impairs motion after extensive loss of integument. Observation seems to show that where cutification is rapid from a number of skin-forming centres, the resulting cicatrix is less violently contractile in its tendency.

For successful skin grafting it is simply essential that a minute portion of skin be removed from a sound part of the body or the patient, or from another individual, and placed on an ulcerated surface. It is customary to take the pieces to be transplanted from the patient's own skin, and I have generally chosen locations where the derma is thin, and not densely covered with cuticle as on most of the front of the body, and, as a choice, from the inner surfaces of the arms and thighs. Grafts from the integuments of other individuals develop as readily, and I have frequently practiced removing them from limbs amputated for traumatic injuries, with apparently equal success. To avoid the possibility of conveying some form of specific infection by the process, it is certainly, as a rule, most advisable to transplant only from the patient's own skin.

A graft of skin should merely consist of the simple structures of cuticle and derma, and should avoid the underlying fatty and connective tissues. That even the whole thickness of the derma is not essential is demonstrated by the fact that successful grafting has been effected by using mere scrapings of the cuticle, in which are contained some cells of the superficial or papillary layer of the derma; but the practice is uncertain and has not practical merit. The thickness of the true skin on the front of the body, it should be borne in mind, does not average from more than a quarter to half a line, and this depth should never be exceeded in the removing of grafts.

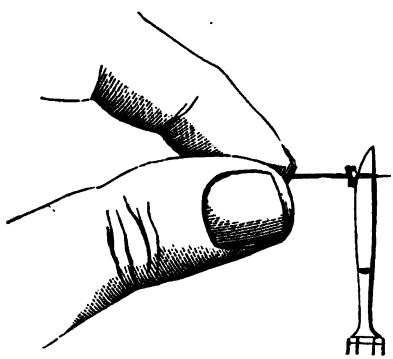
The operation of removing the portions of skin for grafting may be done by a knife or scissors, cutting off minute particles of the size to be used immediately in transplanting; or by taking a larger piece, which is to be afterward subdivided. I have adopted a method first suggested to me by Dr. C. H. Thomas, of Philadelphia, which

for simplicity, convenience, painlessness and effectiveness may well displace all others.

It consists, as seen in the illustration, in merely penetrating the cuticle with a very delicate sewing needle, elevating a small point, and shaving off the minute elevation of cuticle and upper stratum of derma with a very sharp knife. The same may be accomplished, but hardly in so perfect and painless a manner, by using fine scissors for the excision of the portion transfixed.

The operation, if properly performed, should be free from really painful sensation, and patients never object to its most frequent repetition. I have frequently done it without more than a tint of discoloration from blood, and blood need never actually flow from the very minute wound.

The graft is then immediately pushed from the point of the needle, and placed on the surface of the ulcer, the only care being to lay it with its epidermic surface upward. The graft need not be inserted into the granulating surface by making a wound for its reception, as has been advised and practiced, for such puncture allows a flow of blood that may elevate the graft from contact with the granulations.



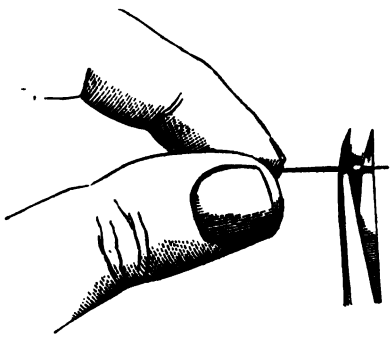
SKIN GRAFTING.

As simple adhesion of the graft is all that is desirable. I have sometimes, with large and actively secreting surfaces, allowed them to be exposed to the dessiccating influence of the atmosphere, so that the secretion may become viscid and hold the transplanted particles surely in position. To facilitate the same object of fixation after the grafts are deposited, I have occasionally allowed the ulcerated surface to remain uncovered until they became well agglutinated to it.

All active medication to the ulcer should be avoided, and the surface of ulceration covered with a light pressing, for protection from disturbing influences. For this purpose the ulcer may be covered with a piece of muslin, saturated with oil or covered with cerate, or it

may be merely protected with the waxed tissue-paper, such as is extensively used for general purposes of a dressing in the Pennsylvania Hospital.

On most ulcers the dressing need not be removed for two or three days after the operation; but when secretion is profuse, the ulcer may be washed daily by allowing a stream of water to flow over it, carefully avoiding the wiping of the surface with sponges or cloths, which may disturb the grafts.



SKIN GRAFTING.

One of the earliest changes noticeable in the graft, after the first few days, is the detachment of its cuticle, which may occasionally be seen floating in the secretions of the ulcer, or it may be detached by a slight touch, leaving the true germinating material fixed in position. The graft, as it commences development as a germinal centre, becomes so blended and identified with the granulations as to be for a time almost lost sight of, its reappearance becoming evident in a bluish or lilac-tinted pellicle, which indicates the progress of cutification.

In regard to the size of grafts for transplanting, I have, in several instances, grafted by removing, from recently amputated limbs, pieces of skin measuring one-third or one-fourth of an inch square; but such large pieces are very likely to fail in retaining their vitality, and I have had much more satisfactory success with quite small grafts; and for reasons already stated this latter practice is certainly the best.

The number and position of the grafts will vary in accordance with the size of the ulcerated surface; and in large ulcers they may be distributed at short intervals, both centrally and near the periphery. Those near the circumference will stretch their granulations outward and stimulate the borders of the ulcer to activity; and with regard to the advantage of centrally-located grafts, it will be well to remember their importance with reference to the difficulty often experienced in eventually healing the last of a chronic ulcer. A large ulcer, on which successful grafting has been performed, will soon present islets from

which cicatrization progresses in directions of the nearest healing points until all are joined by an interlacement of newly-formed tissue.

GURJUN OIL IN SKIN DISEASES.

At a late meeting of the Medical Society of London, Professor Erasmus Wilson showed some of this new remedy, and stated that this material, which was also called wood oil, was an oleoresin, obtained from several species of the *dipterocarpus*, an immense tree growing on the Malayan coast of the Bay of Bengal, where it was so common as to be used instead of paint, for houses and ships.

In March, 1873, Dr. Dougall, of the Indian Medical Service, took charge of the convict establishment of the Andaman Islands, where he found twenty-four of the prisoners suffering from leprosy. He was deeply impressed with the misery of these poor people; and realizing the impracticability of availing himself of all known methods of treatment, he hit upon the idea of trying the gurjun oil, both as an internal and external remedy, and determined upon giving it a six months' trial. Dr. Dougall's method was to have the patients washed thoroughly in a neighboring stream, using dry earth instead of soap. They were then made to rub themselves for two hours with a liniment composed of gurjun oil and lime water, one part to three, and to swallow two drachms of the balsam, also combined with lime water. After this they had their breakfast, and were set to any work they were capable of doing. In the evening the same process was repeated, except the washing. The effects of this treatment, at the end of six months, were marvelous. Neuralgic pains were allayed, sensibility was restored to the anæsthetic skin, tubercles subsided, and ulcers healed. Dr. Dougall was astonished at the energy of these formerly helpless ones.

Mr. Erasmus Wilson remarked that he had used a liniment composed of equal parts of the gurjun oil and lime-water, in cases of painful eczema, in lupus, and in cancer, with very encouraging results, and stated that Mr. Hancock had applied it in a case of cancer of the skin, with the effect of dispersing tubercles and healing ulcerations; but its most useful property was that of relieving pain. A lady in constant pain from cancer of the integument, who had been unable to sleep without narcotics for weeks, was relieved of all suffering, and enabled to sleep, by means of this liniment. Mr. Wilson suggested that this very simple remedy deserved a trial at the hands of the profession, and believed that it would be found a valuable agent of cure in many affections where the skin was painfully attacked.

CURIOUS EFFECTS OF BRAIN WOUNDS.

IN the recent brilliant address of Professor Huxley, before the British Association, "On the Hypothesis that Animals are Automata," he says:

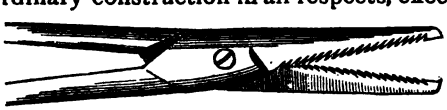
"I am indebted to my friend General Strachey for bringing to my notice an account of a case which lately appeared in the scientific article of the *Journal des Débats*. A French soldier, a sergeant, was wounded at the battle of Bazeilles, one, as you recollect, of the most fiercely contested battles of the late war. The man was shot in the head, in the region of what we call the left parietal bone. The bullet fractured the bone. The sergeant had enough vigor left to send his bayonet through the Prussian who shot him. Then he wandered a few hundred yards out of the village, fell senseless, but after the action, was picked up and taken to the hospital, where he remained some time. When he came to himself, as usual in such cases of injury, he was paralyzed on the opposite side of the body, that is to say, the right arm and the right leg were completely paralyzed. That state of things lasted, I think, the better part of two years, but sooner or later he recovered from it, and now he is able to walk about with activity; and only by careful measurement can any difference between the two sides of his body be ascertained. The inquiry, the main results of which I shall give you, has been conducted by exceedingly competent persons, and they report that at present this man lives two lives, a normal life and an abnormal life. In his normal life he is perfectly well, cheerful, does his work as a hospital attendant, and is a respectable, well-conducted man. This normal life lasts for about seven and twenty days or thereabouts out of every month; but for a day or two in each month he passes suddenly and without any obvious change into his abnormal condition. In this state of abnormal life he is still active, goes about as usual, and is to all appearances just the same man as before, goes to bed and undresses himself, gets up, makes his cigarette and smokes it, and eats and drinks. But he neither sees nor hears, nor tastes nor smells, nor is he conscious of anything whatever, and he has only one sense organ in a state of activity, namely, that of touch, which is exceedingly delicate. If you put an obstacle in his way, he knocks against it, feels it and goes to the one side; if you push him in any direction, he goes straight on till something stops him. I have said that he makes his cigarettes, but you may supply him with shavings or anything else instead of tobacco, and still he will go on making his cigarettes as usual. His actions are

purely mechanical. He feeds voraciously, but whether you give him aloes, or assafœtida, or the nicest thing possible, it is all the same to him. The man is in a condition wherein the functions of his cerebral hemispheres are, at any rate, largely annihilated. He is very nearly—I don't say wholly, but very nearly—in the condition of an animal in which the cerebral hemispheres are extirpated.

His state is wonderfully interesting to me, for it bears on the phenomena of mesmerism, of which I saw a good deal when I was a young man. In this state he is capable of performing all sorts of actions on mere suggestion. For example, he dropped his cane, and a person near him putting it into his hand, the feeling of the end of the cane evidently produced in him those molecular changes of the brain which, had he possessed consciousness, would have given rise to the idea of his rifle; for he threw himself on his face, began feeling for his cartridges, went through the motions of touching his gun, and shouted out to an imaginary comrade, 'Here they are, a score of them; but we will give a good account of them.' But the most remarkable fact of all is the modification which this injury has made in the man's moral nature. In his normal life he is an upright and honest man. In his abnormal state he is an inveterate thief. He will steal everything he can lay his hands upon; and if he can not steal anything else, he will steal his own things and hide them away."

TOOTH-EDGED CUTTING SCISSORS.

DR. B. W. RICHARDSON says: I have recently had constructed for my use a pair of tooth-edged scissors, on the plan shown in the diagram. The scissors are of the ordinary construction in all respects, except in the cutting edge. The cutting edge of each blade, instead of being even and sharp,



is divided into finely-pointed teeth, each tooth being directed with a slight inclination toward the handle of the scissors. When the blades meet, the teeth cross each other; and as they pierce any structure that may lie between them, they crush, also, between their surfaces.

If a piece of moderately firm substance be placed between the blades—a piece of paper or thin card, for example—the scissors perforate it in a series of perforations resembling what is seen in the postage stamp; that is to say, they do not cut clean through the substance, so as to leave it in two distinct parts at once. A little lateral or half-rotating movement of the closed blades is, however,

sufficient to tear through the still connected lines of substance and to complete the separation. The same occcurs if the substance placed between the blades be a portion of soft animal structure, only the more force is required in the lateral or rotating movement to cause complete separation. The parts punctured are crushed between the teeth, and are separated by the twist or torsion.

I find these scissors useful in dividing, directly and quickly, structures in which there are many minute blood-vessels, and which, when divided by the knife, bleed freely. These toothed scissors, as they can be made at one and the same time to pierce, crush, and twist, control bleeding remarkably.

I have put the scissors to a good test in a case of epulis. The tumor was increasing rapidly, and three teeth were involved in it. It was very vascular, had a broad base, and might, at first tight, have been taken for a malignant rather than for a fibrous tumor. The three teeth being extracted, I found I could get a deep grasp of the tumor between the blades of the scissors. I carried the teeth of the scissors well through the base of the tumor, crushing some portion of bone in the way, and gently and easily twisted the mass off, and lifted it away upon the blades without the loss of any blood whatever. The healing in this case was rapid and good. (123)

A NEW PLASTER BANDAGE.

A SURGEON connected with the Southern Dispensary, Brooklyn, N. Y., has recently invented a new method of applying the plaster splint, which, according to the *Tribune*, promises to be an important improvement. A common merino sock is drawn upon the foot and leg. It may extend as far up as is necessary to include the fractured locality. A small rope is run down the back seam in the centre of the leg, around the heel and over the toes, returning up the middle of the instep and front of the leg. Six or seven pieces of flannel are then cut out to fit the leg and foot, allowing for shrinkage. The ends of the bones having been carefully adjusted, the stocking, upon which the rope has been attached as described, is drawn upon the foot and leg. The flannels are soaked in warm water and applied, the plaster of Paris paste being rubbed in with layer after layer. After the last layer has been applied, the plaster is allowed to set. When the plaster has become hard, the splint is perfect, and the patient can get about, on crutches, very comfortably. If the leg swells, and it is necessary to remove the bandage, the whole thing can be done inside of three minutes. The cord that

has been run around the stocking now forms a line of division in the splint. To remove the splint, all that has to be done is to slip out the cord and slit up the stocking along the line where the cord was. Then the splint, divided in halves, can be removed as though it had been laid upon the limb to obtain a cast. Considerable time is thus gained by using this method of applying the plaster splint. When the broken limb becomes inflamed, it also is extremely painful and very tender to the touch. The slightest jar sends a thrill of pain through the body of the patient, who has sometimes been obliged to be chloroformed to enable the surgeon to remove a plaster splint applied with a bandage. By the new method, the limb need hardly be moved or touched.

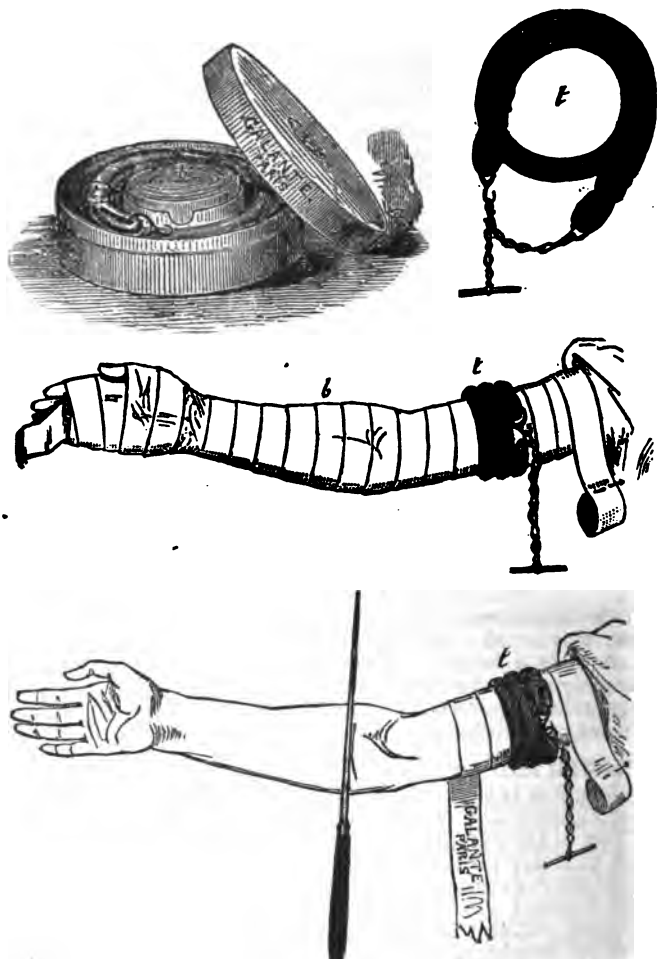
USE OF THE ACTUAL CAUTERY.

THE application of a red-hot iron directly to the living tissues is justly regarded as an extremely painful operation; but if the iron be heated to a white heat, it is absolutely painless. Dr. J. S. Camden, writing in the *Medical Times and Gazette*, recites his experience: "The iron must be heated till it is really of a white heat, and looks almost as white as white paper. If then applied, it destroys the part instantaneously, giving no pain, but it must be removed quickly on the heat decreasing, and then another iron employed. If a red-hot iron only is used, the agony is intense. The first time I saw the cautery used, on a girl of fourteen years, no pain was given; the second time, on an elderly person (both for fungus in the upper maxillary bone), her screeching was fearful, till I told the operator his irons were not half hot enough. He requested me to heat them properly, which being done, not a murmur was heard. The last time was opening four or five sinuses in a horse's shoulder. He never flinched, and scarcely seemed aware of what was being done. I would suggest using—to obtain the white heat for actual cautery—a large spirit blow-pipe."

LAUGH AND BE HEALTHY.—The physiological benefit of laughter is explained by Dr. E. Hecker in the *Archiv für Psychiatrie:* The comic-like tickling causes a reflex action of the sympathetic nerve, by which the calibre of the vascular portions of the system is diminished, and their nervous power increased. The average pressure of the cerebral vessels on the brain-substance is thus decreased, and this is compensated for by the forced expiration of laughter, and the larger amount of blood thus called to the lungs.

BLOODLESS SURGERY.

OUR engraving illustrates the Esmarch process for performing surgical operations without provoking the usual



THE ESMARCH METHOD OF BLOODLESS SURGERY.

hemorrhage. The devices used in connection therewith by the inventor, consist in an elastic bandage, measuring 26 feet in length by 18 inches in breadth, and a tube or cone of strong vulcanized rubber, having a hook at one end and a chain and bar at the other.

The application of the apparatus is very simple. Supposing that an arm is to be amputated, the bandage is tightly wound around the member from the extremities of the fingers up to a little above the point at which the division is to be made. By this uniform compression, the blood is forced back and out of the vessels. At the upper limit of the bandage, the rubber end is passed three or four times around the arm as closely as possible, and fastened in place by the hook and chain, thus preventing the return of the circulation to the member after the bandage is unwound. The latter, on being removed, leaves the arm white and free from blood, and hence ready for the operation, which is accomplished with a very trivial effusion. (9)

IMPROVED LYTHOLYCITE.

HENRY W. BRADFORD, Randolph, Mass.—The inner tube of the apparatus is arranged within another tube, which forms the confining tube for holding a bag, and springs within such compress as will admit of inserting both in the bladder and withdrawing them from it. Spring jaws have the edge of the mouth of the bag fastened to them, and are pivoted together at one end, and at the other end are connected to small steel rods between the tubes. These jaws are provided with mechanism so as to grasp the stone, and a small tube of platinum is inserted after the stone has been secured in the bag, for conducting nitric acid into it for dissolving the stone, so that it will flow out through the inner tube. The invention mainly consists of ingenious mechanism for governing the jaws, etc., to understand which a drawing would be requisite.

SUBSTITUTE FOR THE HYPODERMIC SYRINGE.

IN the Edinburgh *Medical Journal*, Dr. John M. Crombie states that many medical men are often deterred from using morphia hypodermically on account of the expense of the syringes, and the pain they cause the patients. To avoid these, he advises the use of small threads coated with morphia and passed through a fold of the skin by fine needles. The threads may vary in strength from one-sixth to one grain of morphia.

CHARCOAL AND TAR AS A SURGICAL DRESSING.

THE London *Lancet* strongly recommends the use of a mixture of charcoal and coal-tar, containing 33 per cent of the latter, in pulverized form, as a dressing for wounds. The powder exercises no irritative action, and is easily removed by lotions of cold water. The charcoal absorbs gases due to fermentation, coagulates the albumen, and prevents decomposition, in this respect materially aiding the action of the carbolic acid contained in the coal-tar. For wounds which can not bear the contact of the powder, 100 parts of pulverized coal-tar are macerated for some hours in 400 parts of rather weak alcohol. The solution is said to be very efficacious.

DANGERS OF METHYLIC ALCOHOL.

SERIOUS maladies, says the Lyons *Médical*, have been engendered among the workmen in two industrial establishments by the employment of methylic alcohol, that is, wood naphtha, or alcohol derived from wood. The material is used in the finishing of felt hats and of silk fabrics. Its action is directly upon the mucous membrane exposed to its emanations, and also, through the nervous system, upon the entire organization.

The effect is first noticed upon the ocular *conjunctiva*, which becomes inflamed and injected, producing a sensation of sand in the eyes. A copious flow of tears and extreme sensibility to light (photophobia) follow, incapacitating the sufferer for work. Further symptoms include intense coryza and inflammation of the pharynx and bronchial tubes, together with trouble of the digestive organs. Severe headaches and feelings of heaviness and depression are always present. The rigor of the malady depends upon the extent to which the person is exposed to the alcoholic fumes. The workman who finishes the bottom of a hat is attacked more severely than the one who prepares the rim. It has also been noticed that cabinet makers who use the material in varnish are frequently attacked with tetanic convulsions of the fingers, unknown previous to the employment of the alcohol.

MEDICINES GIVEN BY ELECTRICITY.

IT is stated that if the substance to be introduced is placed at both poles, and the current reversed every few minutes, an appreciable quantity can be transferred, quite enough in some cases to produce a serious toxical effect upon various animals, and it is confidently expected that human subjects may be treated beneficially.

THE BAMBOO A DANGEROUS POISON.

THE *Strait Times*, a Javanese journal, publishes some novel information on the poisonous properties of the bamboo, which heretofore has been considered one of the most inoffensive of vegetables. The natives of Java use the poison against their enemies, and obtain it by cutting the bamboo at a joint, and detaching from the saucer-shaped cavity, formed by the cane at such portions, some small black filaments, which are covered with almost imperceptible needles. The filaments constitute the venom, against which no remedy has been found to act. When swallowed, instead of passing to the stomach, they appear to catch in the throat and work their way to the respiratory organs, where they immediately produce a violent cough, followed by inflammation of the lungs. The poison, tried upon dogs, produces loss of appetite, severe cough, burning thirst, and gradual emaciation. The animal froths at the mouth, and finally dies by suffocation, as if under the influence of a deleteric us gas.

MUSCARIN.

MUSCARIN is a poisonous alkaloid, extracted by alcohol from a species of mushroom (*amanita muscaria*). The most interesting feature of muscarin is its antagonism to atropin. These alkaloids neutralize each other's action on the system so perfectly, that each can be used as an antidote in case of poisoning by the other. The pupil of the eye, enlarged by atropin, is contracted by muscarin. The depression of temperature caused by muscarin, injected beneath the skin, is counteracted by a similar application of atropin; and the heart of a frog, that has ceased to beat from half an hour to an hour, under the influence of muscarin, has been restored to activity by atropin. Possibly quinine sustains a similar relation to the poison inducing intermittent fever that atropin does to muscarin.

NEW LOCAL ANÆSTHETIC.

A CORRESPONDENT of the *Scientific American* says: "If a piece of gum camphor be placed in a phial in which there has been previously placed an equal amount of chloral hydrate, each substance begins slowly to deliquesce, forming a very limpid, viscous, and highly refractive liquid. In the course of a few hours, the solution of the two solids will be complete. I have used this camphor chloral or chloral camphor, as a local anæsthetic in neuralgia, and also as an anterotic and hypnotic in the chordee of blennorrhagia, with considerable success."

ICE AS A MEDICINE.

THE great value of ice in certain diseases is not fully recognized by the medical profession, or by the public. Many years ago, it was found by one of the best English physicians—we think Dr. Marshall Hall—that small pieces of ice thrust into the rectum proved a safe and speedy remedy in cases of dysentery, where opiates and sugar of lead had been tried without effect. Very recently, that distressing complaint to which old people, travelers, and others are liable, retention of urine, has been relieved by the same use of ice as mentioned above. This plan is due to M. Cazenave. Common experience has shown that the swallowing of ice, instead of ice-water, by people, in hot weather, is perfectly safe.

PROF. M. SCHIFF, of Florence, has studied the comparative effects of ether and chloroform on the animal economy. Ether, according to him, is preferable to chloroform as an anæsthetic, because etherization, even when pushed to the very last stage of insensibility, is never dangerous to life, so long as one maintains the act of respiration. And even if one presses the inhalation of ether still further, so that the respiratory movements cease, life is never menaced, if, at the moment of the paralysis of the thoracic walls, artificial respiration is immediately commenced. Chloroform has been preferred to ether because it acts more quickly, and its use is more agreeable to some persons. But chloroform has a paralyzing action much greater than that of ether, and, in like manner, has a special influence on the nerves of the heart, and of the vessels.

CARIES IN THE TEETH.

CAREFUL microscopic examination has shown that caries in the teeth is largely due, not merely to the acids of the mouth, but to a vegetable parasite, *Leptothrix buccalis*. Besides this there are other vegetable and even animal growths; these are not much affected, except as to their abundance, by the ordinary means employed to clean the teeth, but soapy water appears to destroy them. The fungus attains its greatest size in the interstices of the teeth, and after the action of acids, taken with the food or in medicines, or such as are formed in the mouth itself by some abnormality in the secretions, which make the teeth more or less porous or soft, the fungi penetrate the canaliculi both of the enamel and of the dentine, and by their proliferation produce rapid softening and destructive effects.

NEW RESEARCHES ON DIABETES.

DR. PAVY has obtained some experimental results which are likely to throw a new light on the subject of diabetes. He has found that the injection of defibrinated arterial blood into the portal system occasions a saccharine state of the urine. In one experiment, the urine after the operation contained fifteen grains of sugar to the fluid ounce, and in others the quantity has amounted to nearly the same.' In the counterpart experiment of injecting defibrinated venous blood into the portal system, the urine showed no signs of the presence of sugar. It thus appears that oxygenated blood passing to the liver causes an escape of sugar from the organ, and thence an accumulation in the system and discharge of the urine. It also appears that through the medium of the respiration of oxygen he has succeeded in inducing a sufficiently oxygenated state of the blood to similarly give rise to the production of saccharine urine. He has further found that through the agency of the inhalation of puff-ball smoke an immediate and strongly diabetic state may be induced, and that the effect is accompanied with such a modification of the circulation that the blood flows through the vessels, as is the case after section of the sympathetic, without becoming properly de-arterialized. His experiments, he considers, suggest that, in diabetes of the human subject, the blood, in consequence of vaso-mascular paralysis, is allowed to reach the portal vein in an imperfectly de-arterialized condition, and thus determines the escape of sugar from the liver. (49)

INTERMITTING LAMENESS.

THE *Doctor* remarks: "A very curious thing has been described by Dr. Sabourin, namely, that lameness may ensue from obliteration of arteries. Horse lameness is often so obscure that any light proves desirable. It is not, however, confined to the horse, but extends also to man. The cause, as observed, is owing to obliteration of the aorta and iliac arteries. Commonly, in previous good health, the subject begins to limp, in one or two limbs to tremble, and finally to fall. Rest is commonly productive of relief. MM. Bouley and Goubaux long ago pointed out the nature of the affection in horses, while M. Charcot first pointed out its occurrence, comparatively rare, in man. Arteritis has been supposed to be the occasion in horses, owing to the violent efforts they have to make, and embolism in men. In any case the occurrence affords a favorable illustration of the advantages of the study of comparative pathology."

CAUSE OF CEREBRO-SPINAL MENINGITIS.

AT a special meeting of the Michigan State Board of Health, held in Detroit, Dr. Henry B. Baker, Superintendent of Vital Statistics in the Secretary of State's Office, and Dr. Bliss, Chairman of the Committee on Epidemic, Endemic, and Contagious Diseases, were recently appointed to visit Petersburg, in Munroe Co., Mich,, to inquire into and to collect evidence concerning an outbreak of an epidemic of cerebro-spinal meningitis reported to have broken out in that place. Dr. Bliss was unable, owing to ill-heath, to accompany his colleague, and Dr. Baker therefore made the inspection. The result of his inquiries led to the discovery of as many as 77 cases; of which 25, or 32.46 per cent, proved fatal.

The patients generally complained, before the outbreak of acute symptoms, of being tired and lame, and in this state they often continued twenty-four hours; they had also, at the same time, pain in the back of the head and down the spine. The acute attack usually began with a chill and a cold stage; but a few persons were taken as suddenly as if they had been knocked down. Vomiting was a prominent symptom before and after the cold stage. About one-half of the patients were rational throughout the attack, but some had violent delirium from the commencement. There was great tenderness of the body, especially over the deep nerves given off from the spinal column. In many cases the head was thrown back, sometimes to one side; and in some cases the eyes were affected with squint, divergent and convergent. The pupils of the eyes were usually dilated, and the eyelids were powerless, so that the sufferers could not wink the lids. Copper-colored spots appeared upon the body in many instances.

The epidemic began on the 3d of March, and continued until June. Out of the first half of the cases, twenty-nine were males; while of the last half, eleven only were males. The deaths took place in all the fatal cases before the seventh day; many on the fourth day, more on the fifth and sixth days, and most on the seventh day of the disease.

Dr. Baker entered into a careful investigation of the cause of the epidemic. But after a study of the local conditions actually found in connection with the epidemic—as those of soil, sewerage, sources of malaria, and general and private sanitary conditions,—he concludes that there was no evidence of any influence capable of acting on the human system through the atmosphere so different in the infected localities from others in which the disease did not exist as to warrant the belief that such influence was the

cause of the epidemic. He reports, therefore, against the malarial view of the origin of the malady, and offers a series of facts tending to show that some poison in the food of the persons affected was the cause. His evidence leads him to the view taught by Dr. B. W. Richardson of the origin of cerebro-spinal meningitis—viz., that it is induced by the eating of a fungus of wheat in wheaten flour, the effects according to this theory being similar to those produced by the ergot of rye. The ergot of wheat, Dr. Baker contends, is more active than the ergot of rye, and retains its properties longer. Its worst effects are not produced by a single large dose, but by continued small doses. The symptoms excited by this agent are, he maintains, the same as those that were observed in the patients who suffered in the epidemic he had to report upon; and he traced the fact that the flour used in the locality of the epidemic was from wheat grown near the spot, which this year contained much diseased grain or smut. The distribution of no other article of food except the flour accounts, he believes, for the origin and spread of the malady.

ACTION OF SULPHUR PREPARATIONS IN CHRONIC LEAD-POISONING.

By the advice of Dr. Liebreich, M. Siew has attempted to chemically combine the lead distributed through the organism, so as to render it harmless. To satisfy himself of the possibility of doing this, he injected subcutaneously some chromate of lead; and after introducing suitable sulphur compounds, he tested for sulphide of lead at those points. If alkaline sulphides were administered, the red color of the injected tissue remained unchanged; but if a rabbit partook of glycosulphuric acid, whch is easily soluble in water, and forms with lead a very insoluble salt, which passes off unchanged from the system, then the injected part showed a black spot. Siew considers this to be sulphide of lead, from the reduction of the glycosulphate of lead. That this salt is really reduced by the organism is proved by feeding animals a long time on glycosulphate of lead, when the walls of the stomach are found to be black. He does not state his conclusions.

Bacteria in Disease.—Dr. Hiller, of Winden, has come to the conclusion, after many experiments, that bacteria are incapable of exciting inflammatory action of fever: that they can not multiply, unless in the presence of putrid material, or after death, through the stoppage of the circulation; but when present after death, this is no proof of their existence before that time, but for reasons as given.

THE GERM THEORY OF DISEASE.

THAT hay fever, a disease quite prevalent during the present month, is traceable to vegetable organisms, is a curious discovery, tending toward the confirmation of the theory that disease is originated and propagated by independent organic germs, recently made by Professor Binz, of Bonn. The investigator has been himself subject to the malady, and has pursued his researches over a number of years.

On examining the nasal secretions with a powerful immersion lens, he found the organisms to be absent except when the disease attacked him during the spring. Then the parasitical bodies were clearly seen in motion, vibrating on the slide and increasing in size after several days. By using a neutral solution of sulphate of quinine, applied by the nasal douche, Professor Binz found that the animalculæ were completely destroyed, and that subsequent examination failed to show their existence in the secretions.

PROTECTION FROM YELLOW FEVER.

IN a report on yellow fever, recently published, it is shown that this disease has never appeared in any climate at the height of 2,500 feet. In the island of Dominica, a hill-top not more than 1,500 feet high is always healthy, even when the fever is epidemic at its base. In San Domingo, similar observations have been made. The highest elevation at which yellow fever has occurred in the United States is 460 feet, in Arkansas; and the medical men of this country now hold that the stratum of air infected by the poison is heavier than pure air, and therefore sinks, and they recommend that in unhealthy districts houses and hospitals should be built on tall piles, so as to be above the fever stratum. But where hills are near, the best remedy will be to carry the patients up to a height of 500 feet.

BORAX FOR COLDS.

A WRITER in *The Medical Record* cites a number of cases in which borax has proved a most effective remedy in certain forms of colds. He states that, in sudden hoarseness or loss of voice, in public speakers or singers, from colds, relief for an hour or so, as by magic, may be often obtained by slowly dissolving, and partially swallowing a lump of borax, the size of a garden pea, or about three or four grains held in the mouth for ten minutes before speaking or singing. This produces a profuse secretion of saliva, or "watering" of the mouth and throat, probably restoring the voice or tone to the dried vocal cords, just as wetting brings back the missing notes to a flute when it is too dry.

DYSPEPSIA CURE, AND USE OF PEPSIN.

THE views of Dr. Schacht concerning digestion have been confirmed by Professor Leube (the inventor of Leube's meat solution), of Jena. He says: 1. No condition of the stomach has yet been observed in which pepsin is altogether absent. 2. The cause of indigestion is generally the absence of sufficient acid. 3. The action of pepsin in a solution of albumen resembles that of a ferment, and it will continue so to act without end, merely by the addition of more acid. 4. Alcoholic solutions, especially wine, on account of the tannin it contains, should be avoided as vehicles for pepsin. Finally, he recommends, in case of indigestion, a solution of chopped meat with water, adding a small proportion of pure muriatic acid, and some thickening. He finds such a solution very nourishing, and reports excellent results. These views and experiments are not novel, but exhibit the old doctrine as to digestion, and it appears to be the sound one. The secretion of the pancreas is now thought necessary to the digestion of fatty substances; and where these are used to any extent—as in cod-liver oil—it would be best to take the new medicine pancreatin, which acts best with an alkali instead of an acid, or to use a little of the solution of the pancreas of freshly killed animals.

TREATMENT OF OBSTINATE CONSTIPATION.—Dr. Macario, of Nice, in a communication to the *Lyon Medicale*, observes that in treating constipation most practitioners confine themselves to enemata, laxatives, or more or less irritating purgatives, which in point of fact rather aggravate than cure the affection. He therefore wishes to make known what he says may be truly termed an "heroic" remedy, which he has employed during twelve years with such constant success that he can not but regard it as infallible.

Constipation, as every one knows, may be produced either by intestinal excitement, with deficiency of secretion (nervous constipation), or in consequence of deficient contraction of the muscular coat of the intestine. Here it is produced by atony or intestinal indolence, which bad anti-hygienic habits have induced and keep up. The prolonged contact of the fæces with the rectum blunts the sensibility of the mucous and muscular tissues, and the synergical contraction of the upper portions of the large intestine either does not take place or does so in an insufficient degree, constipation being the result. In *nervous* constipation the following pill should be given: Pure

sulphate of iron, ten centigrammes; socotrine aloes, five centigrammes; atropine, from one-third to one-half of a milligramme. In the *atonic* form, for atropine one centigramme of powder of nux vomica may be substituted. By the aid of these pills regular stools may be procured, even in the subjects of obstinate constipation due to *ramollissement* of the brain and chronic myelitis with paraplegia. Dr. Macario gives from one to three pills immediately after dinner, the object being to produce one easy, natural, non-diarrhœic evacuation. If more than this is effected, the dose is to be diminished, one or two pills sufficing in most cases. The use of these "antistyptic" pills ought not to be continued indefinitely, a longer interval being allowed to elapse between their administration in proportion as the constipation diminishes, it being of importance to allow the organs to resume their spontaneous action without any auxiliary. If the constipation returns, the pills can be again had recourse to.

NEW REMEDY FOR HAY FEVER.

HELMHOLTZ, having been made aware of the poisonous action of quinine upon infusoria, determined to make an experiment with that substance on the vibrionic bodies he had discovered in the nasal secretion of persons suffering from hay fever, and for that purpose he employed a neutral and weak solution of quinine, which he poured into both nostrils with a pipette while the patient was in the recumbent position, with the head low. The result was most satisfactory, and the cure, which took place in the case of Prof. Helmholtz, has likewise followed in two other patients who made a trial of the remedy. Dr. Frickhöfer, of Schwalbach, and Prof. Busch, of Bonn, have also succeeded in curing the affection by the same method. Prof. Binz suggests that a tepid solution of quinine should be used, and that, instead of a pipette, Weber's simple but effective nose-douche should be employed for applying the quinine solution, care being taken that the quinine is free from adulteration. (49)

PHOSPHORUS AS A CURE FOR CATARACT.—Dr. Combas gives a case of a girl, aged twenty-four, of nervous, lymphatic temperament, suffering from capsulo-lenticular cataract, hardly able to discern light from darkness; suffered frequent headaches. Two or three drops of phosphorized oil were dropped into the eye daily, and frictions of the same used over the forehead. After four months of this treatment, which was used perseveringly, the eye improved, colors could be distinguished, and the opacity of the lens so far diminished that it could not be discerned at a distance of two or three paces.

TESTING URINE FOR ALBUMEN AND SUGAR.

THE following tests by Siebold are so simple that an inexperienced person can employ them for testing urine. In testing for albumen, ammonia is added to the urine until it is slightly alkaline; it is then filtered, made slightly acid with dilute acetic acid, and a portion of the mixture boiled. This portion is compared with the cold portion, when any turbidity is easily detected. In testing for sugar, he employs a modification of Roberts' process, whereby an inexperienced analyist can detect $\frac{1}{20}$ per cent of sugar, while a more experienced person can easily recognize half that quantity. About one and a half or two fluid drachms of Fehling's solution is heated to boiling, and five to ten drops of the urine added. If much sugar be present, a yellow or brick-red precipitate is formed. If this does not happen, add 50 or 80 minims more of urine, and set aside to cool. If the liquid is not milky when cold, less than $\frac{1}{40}$ per cent sugar is present.

NEW DIAPHORETIC AND SIALOGOGUE.

AT a meeting of the Société de Biologie de Paris, M. Coutinho, of Pernambuco, brought under the notice of the members a new therapeutic agent he had brought from Brazil. It belongs to the rutaceæ, smells like hay, but has no taste; the leaves are the active part, but do not appear to contain any alkaloid. An infusion of them, given in drachm doses, produces in the course of a few minutes copious perspiration on the face and over the whole body, quite independently of any outward application of heat, and so abundant a discharge of saliva that speech is rendered almost impossible, and upwards of a litre has been collected in the course of two hours. It also causes great increase of the bronchial secretion. It is obvious that it may be used with advantage in eruptive fevers, bronchitis, pneumonia, and erysipelas. The name of the new remedy is *Jaborandi*.

PRESERVING GUM-ARABIC MUCILAGE.

A WRITER in the *Journal of Pharmacy* states that the instability of mucilage of gum-arabic may be overcome by mixing with tolu water. Tolu water is prepared by rubbing two fluid drachms saturated tincture of tolu with four drachms carbonate of magnesia, and then adding two pints of water, and filtering. It is believed that tolu prevents changes in liquids, upon the same principle and as effectually as benzoin obviates rancidity in unctuous substances. Its preservative influence might be utilized in the preparation of many syrups and mixtures which are remarkable for instability.

MEDICAL USES OF THE TOMATO.

MEDICAL authorities ascribe to the tomato the following very important qualities: 1. The tomato is one of the most powerful aperients of the liver and other organs; where calomel is indicated, it is one of the most effective and the least hurtful medical agents known. 2. A chemical extract will be obtained from it that will supersede the use of calomel in the cure of disease. 3. Diarrhœa has been successfully treated with this article alone. 4. When used as an article of diet it is almost sovereign for dyspepsia and indigestion. 5. It should be constantly used for daily food; either cooked or raw, or in the form of catsup, it is the most healthy article now in use. Tomatoes may be preserved by slightly scalding and skinning them and putting them into bottles; these being set in boiling water for a few minutes, and corked and sealed, the fruit will keep as long as desired, and if eaten when first opened will have the same taste as when just picked from the vines. A better way, perhaps, is to peel the tomatoes, boil them slightly so as to expel the air, and then put them in heated bottles and cork at once. All depends on the exclusion of the air. The more perfectly this is done, the longer the fruit may be preserved. (137)

ICED CLYSTERS IN DYSENTERY.—Dr. Wenzel, having had occasion to treat a great number of cases of dysentery, has found the best remedy to consist in the injection of ice-water into the rectum. It is an inoffensive, economical treatment, and gives extremely satisfactory results. The first case the doctor treated in this manner was one of severe dysentery. There was intense fever, abdominal pains, excruciating tenesmus, and profuse sanguineous evacuations. To check the hemorrhage, injections of ice-water were ordered every two hours, which not only caused the sanguineous evacuations to cease, but also removed the tenesmus, enteric pains and fever. The beneficial effect of these injections was so evident that the patient urgently demanded their repetition whenever the pains threatened to reappear. Dr. Wenzel now considers this treatment more satisfactory than any other in acute cases, although in chronic cases it can only be expected to afford a temporary and palliative effect.

PURE glycerin should not produce, when locally applied, a burning sensation, which it always does when the fatty acids are not all extracted. But even absolutely pure glycerin, when undiluted, is a water-extracting body. It should therefore, when used as a cosmetic, or for medical application, be always diluted with water.

MEDICAL VALUE OF ASPARAGUS AND CELERY.

A MEDICAL correspondent of an English journal says that the advantages of asparagus are not sufficiently appreciated by those who suffer with rheumatism and gout. Slight cases of rheumatism are cured in a few days by feeding on this delicious esculent; and more chronic cases are much relieved, especially if the patient avoids all acids, whether in food or beverage. The Jerusalem artichoke has also a similar effect in relieving rheumatism.

Several plants which grow naturally near the sea-coast contain more or less iodine, and in all rheumatic complaints iodine has long been a favorite remedy.

Iodine is dangerous, however, in over-doses, affecting especially the eyes. The same effect may be produced by eating abundantly of asparagus or celery, which are well-known sea-side plants. If these have no effect, the patent specifics will have none, and in that case a conscientious and intelligent physician is the best resort.

TEST FOR WATER PURITY.

E. REICHARDT proposes the use of the microscope in the determination of the quality of drinking water. For this purpose a few drops of the water are evaporated on a slip of glass, and the forms of the crystals obtained compared with those of known salts, dissolved in water, and recrystallized in the same manner. In this way one can detect with dispatch and certainty common salt, calc-spar gypsum, nitre, etc., and to a certain extent the relative quantities present.

POWDERING CAMPHOR.

G. T. EBERTS, in the *Pharmacist*, says that the methods and suggestions for powdering camphor and retaining this refractory body in its powdered state, have not alone been numerous but curious.

Glycerin is the simplest and most efficient substance to keep camphor in a finely divided state. Take camphor 5 ounces, alcohol 5 fl. drachms, glycerin 1 fl. drachm. Mix the glycerin with the alcohol and triturate it with the camphor until reduced to a fine powder.

ACID IN THE GASTRIC JUICE.—R. Maly finds that the pure gastric juice in dogs contains no lactic acid. The decomposition of chlorides by lactic acid can not, therefore, be the source of the hydrochloric acid in the stomach. Lactic acid seems to play no part in the chemistry of the normal formation of acids. The source of the free hydrochloric acid in the stomach is a process of dissociation of the chlorides without the action of an acid.

THE MICROSCOPE FOR WELL-WATER.

THE author has sought an expeditious method of determining the quality of drinking-water, and recommends the use of the microscope in detecting salts in solution by their crystalline form. For this purpose, a few drops of the water under examination are evaporated on a slip of glass either at a high or low temperature, and the forms of crystals obtained are compared with those of known salts, dissolved in water, and recrystallized in the same manner. In this way one can detect with dispatch and certainty, common salt, calc-spar, gypsum, etc., and to a certain extent the relative quantities present.

AMYLAMMONIUM CHLORIDE.

AMYLAMMONIUM chloride, introduced under the skin of the rabbit, guinea-pig, and dog, causes, in small doses, a marked diminution of the pulse, and some fall in temperature. In larger doses, convulsions are produced which end in death. With man a dose of from 8 to 16 grains lowers the pulse 10 to 20 beats per minute, and occasions a fall in temperature. Dr. Dujardin Beaumetz has administered this salt with advantage in some cases of typhoid fever. Amylamine has not the sedative action on the nervous system which trimethylamine possesses, but surpasses it greatly in its effect on the pulse, and in its toxic action.

PHOSPHORESCENCE.

PHOSPHORUS exists in animal flesh in the state of alkaline or earthy phosphates, and also as one of the elements in protagon. The phosphorescence and alliaceous odor, sometimes observed during the putrefaction of flesh, are due to the formation and subsequent decomposition of sulphur phosphide. This substance, formed from the sulphur of the fibrin and the phosphorus of the protagon, is spontaneously inflammable in presence of oxygen, producing hydrogen sulphide and phosphorus or phosphoric acid.

Muscular flesh to which $\frac{1}{1000}$ part of its weight of calcium phosphate was added, and which was kept at the ordinary temperature, had a very fetid odor by the third day, while a sample not treated with calcium phosphate did not become putrid until the sixth day. As all ordinary waters contain calcium and magnesium salts, it is desirable that they should not be used in the cleansing of ulcers, etc., for, by the combination of these salts with the alkaline phosphates of the flesh, active agents of decomposition are produced.—*J. Lefort.*

NEW METHOD OF DETECTING MERCURY.

MAYENCON AND BERGERET give a method consisting in placing an iron nail, to which a platinum wire is attached, in the urine, etc., acidulated with so much sulphuric acid as to cause a slow evolution of hydrogen. The mercury is deposited in the metallic form upon the platinum, which is taken out after the lapse of half an hour, washed and exposed to a current of chlorine, to convert the mercury into corrosive sublimate. The wire is then gently drawn over blotting-paper slightly moistened with a 1 per cent solution of potassium iodide. If mercury is present, red streaks of mercuric iodide, soluble in potassium iodide, are formed. The method is very delicate and rapid. The authors could always detect mercury in the urine (but not in the saliva, notwithstanding that salivation had taken place) after the internal administration of corrosive sublimate, or inunction with mercurial ointment. They also found mercury in abundance in the milk of a woman 48 hours after inunction.

THE WARMTH OF CLOTHING.

IN a careful study of the subject of the warmth of clothing, recently published, Dr. Max von Pettenkofer has pointed out that the permeability of stuffs to air is a condition of their warmth. The *London Medical Record* gives the following abstract: Of equal surfaces of the following materials, he found that they were permeated by the following relative quantities of air, the most porous flannel, such as is used ordinarily for clothing, being taken at 100. Flannel, 100; linen of medium fineness, 58; silk, 40; buckskin, 58; tanned leather, 1; chamois leather, 51. Hence, if the warmth of cloth depends upon the degree in which it keeps out the air from our bodies, then glove kid must be 100 times warmer than flannel, which every one knows is not the fact. The whole question, then, is resolved into that of ventilation. If several layers of the same material be placed together, and the air be allowed to permeate through them, the ventilation through the second layer is not much less than through the first, since the meshes of the two form a system of continuous tubes of uniform diameter, and the rapidity of the movement of the air through these is effected merely by the resulting friction. Through our clothing, then, passes a stream of air the amount of which, as in ventilation, depends upon the size of the meshes, upon the difference of temperature between the external and internal atmosphere, and upon the velocity of the surrounding air. Our clothing, then, is required, not to prevent the admission of the air, but to

regulate the same so that our nervous system shall be sensible of no movement in the air. Further, our clothes, at the same time, regulate the temperature of the contained air, as it passes through them, so that the temperature of the air between the clothing and the surface of our bodies averages 84° to 86° Fahr. The hygroscopic property of different materials used for clothing essentially modifies their functions. This property varies with the different materials: wool, for instance, takes up more water than linen, while the latter takes up and gives off its watery contents more rapidly than the former. The more the air is displaced by water from the clothes, the less will be their power of retaining the heat; in other words, they conduct the heat more readily, and hence we are quickly chilled by wet garments.

A SIMPLE METHOD OF REMOVING THE TEETH OF CHILDREN.

THE operation consists in simply slipping a rubber ring over the tooth and forcing it gently under the edge of the gum. The patient is then dismissed and told not to remove the appendage, which in a few days loosens the tooth and causes it to fall out. Grown children, who shrink from the shock and pain of the dental nippers, may also have their teeth removed by means of the rubber, which is a mild form of treatment.

FLOATING PARTICLES IN THE AIR.

WHEN a ray of sunlight crosses a shaded room, an immense number of fine particles will be noted, apparently in suspension therein. M. Tissandier has recently made some investigations into the quantity of this dust contained in 35.3 cubic feet of air, by causing that quantity of air to pass through a tube packed with gun-cotton, which filtered out the particles. He afterwards dissolved the gun-cotton in ether, and thus was enabled to obtain the particles in a separated condition. After a heavy rain, M. Tissandier has collected .09 grains of dust in the above-mentioned quantity of air, but during dry weather this proportion rose to .3 of a grain. With regard to the nature of the material, he found that about one-third was organic, another third silicious, and the rest composed of various substances and sulphate and oxide of iron.

THE OPTIC NERVE—By a microscopic examination of the retina and optic nerve and the brain, M. Bauer found them to consist of globules of $\frac{1}{2500}$ to $\frac{1}{4000}$ of an inch in diameter, united by a transparent, viscid and coagulable gelatinous fluid.—*E. Lovett.*

COLD APPLICATIONS TO THE NECK.

DR. B. B. RICHARDSON recommends a neck-bag of rubber, with a constant stream of cold water through it, as an efficient means of applying cold locally to the neck. He says:

I have used this method of applying cold to the cervical region now several times, in pyrexia, with increasing confidence in its usefulness. In a case of apoplectic seizure, with convulsions, in a lady of middle age to whom I was summoned, I found a temperature of 102° Fahr., with deep unconsciousness, rapid pulsation of the carotids, and intense fullness and tension of the jugular vein. In this extreme instance I had the cervical region enveloped in a bladder of crushed ice, with the result of a fall of temperature to the natural standard in six hours, a quiescent condition of the circulation, and subsidence of all the acute symptoms, so marked in character, that it is, I think, impossible to doubt that cause and effect were in their true place. This patient made a good recovery, and, although I do not attribute the recovery solely to the special remedy now being considered, I am convinced the remedy was of good service.

I had an opportunity of trying the effect of this mode of applying cold on myself. I took a feverish catarrh, attended with a rise of animal temperature to 100° Fahr. I had the bag neatly adjusted, and let pass freely through it water, taken simply from the cistern, the temperature of the day being at freezing-point. As the water current began to pass over the front part of the neck, with a gentle pressure which I regulated myself by the stop-cock, I felt the effect of the cold very deeply, and at first not pleasantly. In three or four minutes, however, though the skin over the throat was ten degrees lower than on the other parts of the body, the sensation of cold was lost, and all unpleasantness was gone. Within a quarter of an hour I was conscious of a general reduction of fever, and of lessened vascular activity. The cold also had a soothing influence, producing desire for sleep. On this followed perspiration, and within two honrs a reduction of the temperature to the natural standard.

These effects were satisfactory, because no other mode of treatment was employed to complicate the experience.

I shall look out with interest for the results of the observations of other practitioners on this subject of reducing pyrexia. It stands on a good physiological basis; I believe its practical worth is clear; and I would that its usefulness were tested by the independent observation of other workers in our common field of labor.

I would urge on those who may study the effect of cold, more or less extreme, applied to the cervical region, to observe the influence it exerts in different classes of cases upon the heart. If I am correct that it reduces the action of the heart, and if I am also correct in the view that it promotes a tendency to sleep, this remedy so simple will prove useful in many other forms of disease than acute pyrexia. In acute mania, in cases of insomnia, in cases of palpitation and cardiac irritability, it deserves the test of experience. (123)

LIFE IN AN ATTENUATED ATMOSPHERE.

M. PAUL BERT, in a communication to the French Academy, details some further experiments made on himself, with reference to the effect of changes of barometric pressure on life. He entered his large apparatus of decompression, and the pressure was brought down from the ordinary pressure of 15 lbs. per square inch to 9 lbs.; it was then maintained between this and 8¼ lbs. for a little over an hour. These pressures correspond to heights of 13,448 and 16,728 feet. At 9 lbs. the author began to experience "mountain sickness"—a feeling of heaviness and weakness, nausea, fatigue of sight, general indifference, and laziness. Having lifted his right leg, it was thrown into convulsive trembling, which extended to the left, and lasted some minutes. The face was somewhat congested, and the temperature under the tongue increased. He also remarks that he was unable to whistle. The important point of these experiments, however, was this: he had taken with him a small vessel full of oxygen, and, when the pressure had reached 8⅛ lbs. he inhaled some of it. His pulse, which had risen from 62 to 84, immediately fell to 71, and the mountain-sickness for a time disappeared. Immediately on inhaling the oxygen there was a disagreeable dazzling, and at one time, after three inspirations, he became giddy and fell off his chair, but soon recovered. The author also describes the effect on himself of breathing a superoxygenated mixture. With a mixture of 45 per cent he could bear without injury a pressure of only 6¼ lbs., which corresponds to the height of Chimborazo; and with 63 per cent he was able to stand 5 lbs. per square inch, and would have gone farther if his machine had been sufficiently strong. Since M. Bert's experiments, Messrs. Croce-Spinelli and Sivel have made a balloon ascension to the extraordinary height of about 26,000 feet. They carried up with them a supply of oxygen, and by using this after the manner indicated by M. Bert, they were enabled to live without inconvenience in an atmosphere of extreme rarity. (77)

EFFECTS OF IMAGINATION.

AT a late meeting of the Paris Académie des Sciences, a letter was read from M. Volpicelli, of Rome, in which the writer related that a Roman physician had asserted to him that, if a magnet were brought near to a nervous patient, magnetism had the effect of disturbing him in various ways, and notably in his condition of health. M. Volpicelli goes on to state that, being subsequently invited to experiment on a nervous subject at the San Spirito hospital, Rome, he practiced a little *ruse*, and instead of taking with him a magnet, provided himself with a piece of unmagnetized iron. The patient scarcely saw the piece of iron before he fell into convulsions; his imagination became so highly excited that nervous disturbances of the most extreme character supervened. M. Volpicelli then made a second experiment. A magnet was placed in the hand of another person suffering from nervous disorder, who, when a few minutes had elapsed, was so extremely excited that it was necessary to take the magnet from him. M. Volpicelli, however, was convinced that the nervous disturbance was brought on by the sight of the magnet and not by magnetic action, and he was subsequently able to assure himself of the fact. The same Roman physician had to preside over a scientific meeting, and M. Volpicelli contrived to surround him with very powerful magnets, which were introduced into his chair, into the drawer of the table before him, and even under his feet, without his having the slightest suspicion of the trap laid for him. During the meeting, which lasted more than two hours, his nerves were not in the least effected; and when the meeting was over he declared, in answer to a question put to him by M. Volpicelli, that he was perfectly well; but when it came to his knowledge that he had been surrounded by powerful magnets, he was extremely surprised and alarmed, and began to have an idea that he could not have been so well as he thought.

VELOCITY OF SENSORY IMPRESSIONS.

THE fact that two observers rarely agree exactly as regards the time at which a star passes the meridian, has led Dr. Sigmund Exner to determine the time that elapses between the sensory impression and the motor act following it. This, he finds, varies in different persons from 0.35 to 0.12 of a second, the difference depending chiefly on the age. In quick, energetic people the reaction time is longer than in the phlegmatic, exactly the opposite of what was to be expected.

HYGIENIC TREATMENT OF THE AGED.

MR. HABERSHON, in a clinical lecture at Guy's Hospital, London, referring to the case of an old man, remarked: "The man died simply from the shock produced by coming out into the cold and fog, which, though only an inconvenience to us, was sufficient to lead to a fatal result on one whose circulation had become enfeebled, and whose vital force had so nearly lost its power. I am reminded, by this case, of an instance of longevity communicated to me by a gentleman the other day. His mother, who had died at the age of one hundred and two, during the winter months 'had refused to get up, saying that she was only warm in bed.' I have no doubt that it was owing to this uniform, warm temperature that she lived so long; and I mention the instance as a recommendation for you, when you have to prescribe for old people, to advise that they be kept warm. You should also look carefully after their nourishment. Old people can not eat large meals, therefore they must take them more frequently. Many old people will wake up about three or four o'clock in the morning. It is a good plan that they should have some nourishment then; otherwise the interval between the night and morning meals is too long for their declining strength. It is by care in such minutiæ that we may prolong the life of the aged."

MENTAL CAPACITIES OF CHILDREN.

DR. W. LAUDER LINDSAY, a physician in charge of a Scotch lunatic asylum, but who has long been a special student of the subject of mind in animals, has sent a brief communication to *La Nature*, giving the results of some experiments upon the mental capacities of children of different racial descent. The observations were made by Monsieur J. C. Houzeau, also a comparative psychologist, and author of "Studies on the Mental Faculties of Animals compared with those of Man." The observations were made in Jamaica, upon children inhabiting that island, and M. Houzeau states his experiments and conclusions as follows, in a letter to Dr. Lindsay:

"I have been busy, meanwhile, on a curious study about the comparative development of intelligence of children belonging to different races. I had an opportunity here to submit to the test black, brown, and white children. Fifteen of them were sent to me every day for two hours by their parents, my country neighbors; three of them white, seven colored of various shades, and five black. For a whole year I gave them myself common instruction, and carefully watched their proceedings and their rate of improvement. I do not expect to publish

anything about that experiment, at least at this time. But I will state here the conclusions to which it has led me :

"1. There is in each child a different degree of intellectual proficiency which could be called, in mathematical language, his or her 'personal coefficient.' However, these individual differences are much less than I had anticipated, and are not the striking feature in the unequal rate or speed of improvement.

"In this unequal speed, I see nothing—at least nothing clearly and unmistakably discernible—that can be referred to the differences of race. This will probably appear strange, after all that has been said of 'inferior races.' Should other facts show that my experiment was not properly conducted, and that the trial was not conclusive, I am ready to give up. Still, it is at least my 'provisional conclusion.'

"The rate of improvement is due almost entirely to the relative elevation of the parental circle in which children live—the home influence. Those whose parents are restricted to the narrowest gauge of intellectual exercise live in such a material and coarse *milieu* (medium), that their mental faculties remain slumbering and gradually become atrophied ; while those who hear at home of many things, and are brought up to intellectual life, show a corresponding proficiency in their learning."

Experiments upon so small a scale, and continuing for so short a time, must, of course, be inconclusive, for, as Dr. Lindsay remarks, "at or up to a certain age, girls are as sharp as or sharper than boys at lesson learning and repeating. Cases are constantly being recorded—perhaps paraded—in the newspapers of girls or young women beating boys or young men of equal age in competitive examination, and yet it is not to be inferred that the female mind is either superior or equal to the male, that is, in a comparison of averages. For the fact is, that throughout the animal series, including man, the female mind is, in some respects, different from, and inferior to, that of the male. We know, moreover, that female superiority, when it exists, is usually, at least, confined to school-life. In subsequent intellectual development proper, man, as a rule, far surpasses woman."

But, while M. Houzeau's observations were quite too restricted to form a basis of useful conclusions respecting the educability and intellectual capacity of the children belonging to different races, there is a great significance in his final conclusion regarding the potency of home influences. This is no new truth, but it is a truth of transcendent importance, too much neglected, and its confirmation under such peculiar circumstances is noteworthy.

LIVING DEATH.

A PARAGRAPH by Professor Redfern on biology, furnishes a curious confirmation of the axiom, "we die daily." Referring to the blood, it is said that the duration of life in any of its particles is but short; they die and their places are occupied by others, and so continues a substitution which only ends with death. After every meal an amazing number of white corpuscles are added to the blood; breakfast doubles their proportion to the colored corpuscles in half an hour; supper increases their proportion three times, and dinner makes it four times as great. They come from such solid glands as the spleen. In the blood going to this organ, their proportion is one to two thousand two hundred and sixty; in that returning from the spleen, it is as one to sixty. Perhaps the most stupendous miracle of organization is the steady maintenance of but slightly variable characters in the living and moving blood, which is every moment undergoing changes of different kinds as it circulates through each tissue and organ in the body.

TIME IN NERVOUS TRANSIT.

SOME experiments have recently been made by Exner to determine the reaction time of the sensorium, that is to say, the time required to convey an impression along the nerves to the brain, and to convey an order from the brain to any portion of the body, together with the interval required by the brain to deliberate and act. Exner's method of observation consisted in stimulating some portion of the body and requiring the person immediately to make a signal by pressing a telegraphic key with the right hand. Marks were produced on a blackened cylinder both at stimulation and at signaling, and the interval was noted by the ordinary methods of the chronograph. The reaction time ranged between thirteen and thirty-six hundredths of a second, and seems independent of age, being shortest in those who have the habit of concentration. The tables also show it to have been shortest when the stimulation was applied to the eye by means of an electric shock, and then follow in order an electric shock given to the finger of the left hand, a sudden sound, an electric shock to the forehead, a shock to the right-hand finger, the sight of an electric spark, and lastly, a shock communicated to the toes of the left foot. (120)

IN a French industrial establishment, employing 630 men, chiefly vegetarians, the sick fund was constantly in debt. By the introduction of meat into the food of the men, the average loss of time per man, on account of illness or fatigue, was reduced from 15 to 3 days per annum.

THE AUTOPSY OF PROFESSOR AGASSIZ.

DR. MORRILL WYMAN, of Cambridge, Mass., has published a report of the autopsy made upon the body of Professor Agassiz, from which it may be deduced that the disease to which the great naturalist succumbed was one of long standing. The arteries at the base of the brain showed evidence of extensive chronic disease of their lining membrane, and also several important changes which were fatal. In the left ventricle at the lower third, a firm, organized clot of the size of a peach-stone, attached to the wall at the anterior portion near the septum, was found, and around this clot a more recent one had formed, its centre softened and granular. From this, probably some small portions had been carried by the blood to the arteries at the base of the brain, doing their part in obstructing them and causing the fatal alterations above noted. The lungs showed evidence of old inflammation. The entire weight of the brain was 53.4 ounces avoirdupois, and its greatest weight, between the ages of 35 and 40 years, was estimated at 56.5 ounces.

Without entering into the technical details of the investigation, the result shows that the trouble began with inflammation of the lining membrane of the lungs, and that the morbid processes, carried by the blood from heart to brain, there disorganized and checked the circulation. The malady was too deeply situated to have admitted of surgical aid, nor could any effort of human skill have averted death from its effects. The autopsy was made in the interests of science and in deference to the expressed wishes of Professor Agassiz, long since placed on record.

SCIENTIFIC MEN SCIENTIFICALLY STUDIED.

MR. FRANCIS GALTON, well known for his researches in regard to hereditary mental powers, has been pursuing these studies. He made personal inquiries of one hundred and eighty leading scientific men of the day, and on their replies based his conclusions. Most important was the almost persistent combination of remarkable energy of body with remarkable energy of mind. Size of head was considered, and, as a general rule, was larger than of ordinary gentlemen. Still, remarkably many scientific men had small heads, and the small heads were remarkable for activity. Health was a marked feature. Independence of spirit and tenacity of purpose were also most marked characteristics of men of science, and notably a large proportion were men of business, as principals of large commercial or mercantile concerns. The great incentive to science seemed, to the author, to be innate taste, and in character

he regarded the scientific mind as anti-feminine. As to hereditary qualities, that of health seemed most essentially due to parentage; and on the parental side the influence of qualities was apparently on the father's side, in the proportion of 128 to 45 on the mother's side. A combination of all essential qualities seemed necessary to the production of a man of mark, and that the laws of chances and alternatives came in to give actuality to results. In regard to education, the general condition seemed to be that they were not tied down in their studies to particular subjects, but were given to the investigation of many.

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INJURY TO THE EYES OF WORKING PEOPLE.

THE surgeons at ophthalmic hospitals and eye infirmaries find that far more persons suffer from over-use of the eyesight than from external injuries. Needlewomen, tailors, handloom-weavers, copying clerks in law-writers' offices, lacemakers and embroiderers, try their eyesight very severely by close application in a stooping posture during many hours of the day (and often night). These kinds of work are not injurious in themselves; the evil results from long hours. Tailors suffer from this; but they suffer also from the prevalent use of black cloth for men's garments, black work being more trying to the eyes than white or colored, if long continued; while the want of fresh air in their heated workshops leads to a catarrhal ophthalmia when they go into the open air. The natural remedy for these evils is obviously a lessening of the hours of strain upon the eyesight, coupled with improved ventilation.

When many hours of evening work are done by gas-light, the eyes are much tried by the strength and glare of the flame. This is often experienced in large tailoring and dressmaking establishments, and in the shops of watchmakers and engravers—especially when, as in the last two cases, magnifying-glasses are used. The glare of furnace-light and fire-light is felt by smelters, founders, blacksmiths, cooks, engine-men, and stokers. Haymakers, harvesters, and sailors know from experience how dazzling sunlight distresses the eye. In all these cases, prevention is impracticable; but a lessening of the evil may be effected by judicious arrangements.

Just as the delicate organism of the eye protests against exposure to more light than is necessary for the work in hand, so does it object to a deficiency, which leads to a straining of the focalizing power. When tailors and dressmakers work in large establishments, they are, as we have just said, often exposed to an intensity of gas-light;

but when working at their own homes, they too often make one tallow candle suffice in the evening, giving out a light insufficient for the purpose. Mr. White Cooper, surgeon of St. Mary's Hospital, states: "I have invariably found that a general mourning increases the number of applicants for relief at the ophthalmic institution to which I am attached, owing to the blank, dreary, wearing, wearying obscurity of the light from black work. Fine work has some such effect as dark work upon the sight; for the eyes ache in the endeavor to appreciate each minute spot on the work to be done." The evil suggests its own remedies so far as they can be applied—more light and fewer hours of work.

The light to which a workman is exposed may be neither too much nor too little; yet, if badly applied, it will distress the eyesight unnecessarily. There may be a flickering motion in the flame of a gaslight, or it may be at too low a level, or it may be unrelieved by sufficient color. It is known to the Chinese embroiderers—who often produce exquisite work—that the eye feels the comfort of having a greenish tint diffused through the room by means of green blinds and curtains; and ophthalmic surgeons recommend this custom to the attention of dressmakers, lacemakers, and needlewomen generally. It is also advantageous to change, as frequently as may be, the color of the cloth or textile wrought upon.

Numerous other sources of injury to the eyesight admit of no precise classification. Shoemakers, for instance, especially the humble cobblers, often damage the sight irretrievably by smoking short pipes when at work; with stooping head, the eyes are just over the pipe, and get more than their proper share (if there *is* a proper share) of the tobacco smoke.

The committee of the Society of Arts have made several useful suggestions tending to lessen many of these causes of injury to the sight. Physicians say that beards and whiskers tend to arrest some of the dust and particles that would otherwise reach the eyes, besides having a strengthening and tonic influence on the nerves of the face and eyes; they are useful in this way, but should, of course, be kept clean. Goggles, wire-gauze spectacles, and other forms of eye-protectors, are known to be advantageous to men employed in various trades where dust and fine particles are unavoidable. Frequent laving of the eyes with clean water is in many cases a most useful practice. Daylight work, instead of gas-light or candle-light, wherever practicable; reflecting screens or shades over gas and lamp-glasses, to throw down the light on the work,

instead of into the eyes of the worker; as frequent changes as possible in the size and color of the articles worked upon; an avoidance of too long working at one sitting; avoidance, when practicable, of black work and artificial light—these are remedial measures, obvious enough, to lessen, at any rate, the evils complained of.

EXPERIMENTS ON THE INORGANIC CONSTITUENTS OF FOOD.

J. FORSTER observes that the experiments of Chossat and A. Milne-Edwards seem to show that animals can not grow without a supply of salts. He criticises the experiments of Magendie, Wundt, Klein and Verson, Kemmerich, and others on the effects of a deficiency of salts on adult animals. Some of these with washed fibrin show that albuminous substances can be digested even though no salts are given. In some of the experiments the result was not due to want of salts, but to want of albumen. The salts in the body may be divided into two classes: 1st. Those which are firmly combined with combustible substances in the body, and are indispensable ingredients of the juices and blood. 2d. Those which are simply dissolved in the juices. These latter greatly exceed the first class in amount, and consist of those salts which are introduced into the body or are liberated by the decomposition or oxidation of combustible substances in the organism. Those of the first class can not leave the organism so long as they remain in combination in organized structures, and even when they are simply dissolved in the juices, the arrangements in the kidneys hinder their exit from the body. This is proved by the experiments of Bidder and Schmidt, which show that chlorine quickly disappears from the urine when chlorides are withheld, although it is still abundant in the body; by those of Voit and Bischoff, which show that nitrogen and phosphoric acid rise and fall in the excretions when flesh is put on or lost from the body; and those of Kemmerich, which show that when potash and earthy salts are given, but soda withheld, the soda in the blood continues normal, the potash only being excreted. The author's experiments, made by feeding pigeons and large dogs with albumen, starch, fat, and water without salts, showed that the animal organism, though kept in equilibrium as regards the supply of other nutriment, requires for its support a supply of certain salts, and if this supply is defective or entirely absent, the body loses salts and is thereby destroyed. When the mineral constituents are removed as much as possible from the

food of an adult animal, the processes of tissue change; destruction and decomposition in the body proceed until the death of the animal, in the same way as when the food contains inorganic constituents. Gradually, however, derangements occur in the functions of various organs, which finally hinder the conversion of nutriment into absorbable modifications, and thus prevent the reparation of the combustible materials of the body. On the other hand, by arresting some of the processes necessary for life they occasion the destruction of the organism before the impossibility of absorbing nourishment could produce decline and death.

The excretion of inorganic substances, though much diminished, continues during the whole time that salts are withheld. It is least at the very time that the supply of combustible material is most abundant, as then the tissues of the body are protected from decomposition, and the salts they contain are retained. Although the salts of the body are to a great extent retained and used over and over again, yet a certain proportion of them is excreted, and when salts are withheld and other food given the consequences are, 1st, that the whole body, and especially the parts in which destruction goes on actively, such as blood and muscle, become gradually poorer in salts and richer in albumen; 2nd, that although the total quantity in the body is lessened, the mixture of salts in organized structures and in the juices remains unaltered. The diminution of salts in the muscles causes muscular exhaustion, and in the nerves causes, first, excitability, and then paralysis of the nerve-centres. The quantity of salts necessary in the food is less than has hitherto been supposed, but further experiments are required to determine its exact amount.

ACTION OF PROJECTILES ON ANIMAL BODIES.

THE following are the results of some most interesting experiments made by the German Surgical Society in regard to the action of bullets in the animal body. It seems that these studies were instigated by the Prussian Minister of War, and an officer with arms, ammunition and soldiers, not to be shot at, but to shoot at animals, were placed at the disposition of the doctors. Last year Professor Busch, of Bonn, drew attention to the fact that the Chassepot bullet, when shot at a short distance into the human body, made a simple aperture of entrance, but that its aperture of exit was larger than the fist, and that there was extensive fissuring and crushing of the bones. Dr. Busch supposed that the ball became melted and broken up by the forcible contact with a hard substance, and

acted like a mass of shot on the parts lying behind. In the experiments made, animals were taken and behind them was placed a target, so that the condition of the bullet could be determined after passage through the animal. The distances of firing were from point-blank to 800 paces. Sporting rifles, the needle-gun, the Chassepot, Mauser, and Henry Martini rifles were used. The commission arrived at the conclusion that the action of a projectile on the living or dead animal was almost precisely the same as to disintegration of parts. As to the extent of the destruction, it was in inverse ratio to the distance, and in direct relation with the initial velocity of the bullet. At 800 paces, although the peculiarities of the wound were the same, they were reduced in intensity. With small sporting rifles the bullets, though out of shape, remained in the body, though the military arms produced fearful destruction of the bones and soft parts. The most curious portion of the report is that relating to the change in the form or cohesiveness of the ball, owing to the sudden changes of the temperature, caused by friction in the barrel, resistance to the air, and the heat caused by collision against a solid substance. It is well known that the bullet is broken up and mechanically divided. The particles of lead were found in the recesses of the wound, while fragments of various sizes passed out with pieces of the shattered bone.

To discover whether the heat was appreciable, a small bag of gunpowder was placed before the target. The bag was repeatedly torn by splinters of the balls, but no ignition of the powder took place. The question of the cohesion of lead was then experimented on, by taking two leaden balls, one cold, the other hot, and dropping them at the same elevation on a stone, when the warmer ball was distinctly flattened. That a ball, then, must heat when it strikes the body of an animal, is but following the simplest of physical laws. Having this fact perfectly established, the peculiar injury produced in the animal body is perfectly explained. The bullet strikes against the bony structure, develops heat, and is disintegrated. The experiments showed that most of the bullets, after passing through the animal, made on the targets an irregular impression, surrounded by an aureole of smaller pieces of lead.

A very nice point comes in just here, and that is in regard to the relative action of hard and soft bullets on animals. When the Russians were fighting the Circassians, Schamyl's followers, for want of lead, used copper balls. If we remember rightly, when we fought with Mex-

ico, the Mexicans used occasionally the same metal. We use to-day, in almost all our arms of precision, leaden balls, which are swedged and considerably hardened. The Martini Henry, we think, uses a ball made of twelve parts lead and one of tin. Hardened balls, then, when fired into animals, crush or radiate but very little. Dr. Künster states that in such cases splinters of hardened lead, or of the mixture of metals, were rarely found. "If the edge of a rib was struck, the loss of bone formed the segment of a circle corresponding to the circumference of a ball. Of two balls, one fired at 100 paces at a horse, and passing through the greater diameter of the animal, the Martini ball went clean through, while the Mauser ball remained in the carcass. The explanation was the greater resistance which the latter had to overcome by the misshapement of the ball, it being of a softer material." Now here the question arises as to the use of hard or soft metal, as projectiles for killing animals. It is difficult to form a very clear opinion of their positive action on the animal economy. If the harder ball goes clean through the animal, the shock must be immense, but hardly less so is that of the softer bullet, which must inflict fearful internal injuries. In fact, the softer ball seems to play the part of an explosive bullet, and at a close range, with such bullets, the effect must be almost the same as if filled with a fulminate. Of course, in practical military surgery, questions of this character are of vital impartance.

Sportsmen on the plains, when in pursuit of our large game, by noting the action of projectiles on animals, following, as it were, the track of the rifle ball, might add immensely to our stock of knowledge in regard to this subject, and army surgeons and the world at large might be benefited with the information thus acquired. (119)

CURE OF RHEUMATISM IN A HORSE BY ELECTRICITY.

G. D. POWELL, M.D., in the *Irish Farmers' Gazette*, describes the cure of a valuable horse by means of electro-puncture needles, from four to six being inserted in the principal muscles of the fore-quarters, also along the spine and hind-quarters. The battery employed was that of Leclanché, from four to twelve large cells, alternating in strength, and the current broken, causing the muscles to contract perceptibly. This was kept up from two to three minutes at each place. Prior to treatment, the animal was in so bad a condition that the owner was about to cause him to be shot. But within about six weeks after the commencement of the electrical treatment, the horse was perfectly restored, and is now sound and useful.

THE GLYCOGENIC FUNCTION OF THE LIVER.

By B. LUCHSINGER.—In experimenting upon fowls, it was found that when these are fed for many days upon food containing none of the carbohydrates, the liver contains no glycogen, or only traces of this substance; but the muscles contain considerable quantities of it. It was proved that the substance agreed in chemical and physical properties with true glycogen.

With both fowls and guinea-pigs the injection of glycerine into the stomach after the above-mentioned diet had been used, increased the amount of glycogen both in the muscles and in the liver. It was ascertained that, excluding glycerine, no substance when injected increased the amount of glycogen in the liver and muscles, except such bodies as belong to the group known as carbohydrates. Injection of other easily oxidizable substances was without effect.

It is surmised that glycerine increases the amount of glycogen in the liver, not because it is readily oxidizable, and so saves the glycogen from oxidation, but because glycerine, in part escaping oxidation, reaches an organ where it can be metamorphosed into sugar.

COLORING OF BONES.

By H. WEISKE.—Rabbits of various ages, from six weeks to six months, were fed with bran mixed with 5 per cent of powdered madder, and their bones were examined with regard to their color after different periods of such feeding. The coloring was found to begin first, in the older animals, at the point of ossification of the intermediate cartilage of the femur; it was faintly visible after three days, and extended gradually along the walls of the central cavity of the bones and in a layer under the periosteum. The reddening always extended farther towards the middle of the diaphysis in the walls of the central cavity than in the layer under the periosteum, and was darker in the older animals than in the younger. The dung of the animals, which was colored red after one day's madder feeding, continued so for many days after the madder was stopped. The bones of a rabbit which had received madder for 34 days, and had then been fed on unmixed bran for 14 days, were as much colored as those of an animal killed at the end of the 34 days; after 28 days' cessation of the madder, the color had but slightly gone; the time of total disappearance of the color was not observed. A section of the femur or tibia taken near the end of the diaphysis showed that the whole of the osseous tissue was colored, but not the intercellular matters. Nearer the middle of

the diaphysis, three parallel concentric layers were visible, the two outer ones colored, and the middle one colorless; the coloring did not extend to the middle of the diaphysis. The cartilage left on treating colored bones with dilute hydrochloric acid was still colored, while the calcium phosphate precipitated from the acid solution showed no trace of color, indicating that the coloriug matter is fixed by the organic matter of the bones.

MILITARY PHYSIC—A CURE FOR SCURVY.

GENERAL SHERIDAN'S name is pretty widely known as that of an able officer in the United States military service, but probably few are aware that he gained his first laurels in combating disease. The *Pall Mall Gazette* states that when a young officer he was in charge of an isolated post in Texas, where scurvy in a serious form attacked the men under his command. No lime-juice or vegetables were to be had; but Sheridan had heard that the juice of the Mexican agave had antiscorbutic properties. He therefore organized an expedition to search for the plant, and a grove of it being discovered about a hundred miles distant, a supply of it was procured, the juice expressed, and the men compelled, not without many wry faces and some protests, to take it in liberal doses. But the military doctor and pharmacist was successful, and from that time the disease was effectually stayed.

ELECTRIC SPHYGMOGRAPH AND SIGNAL.

BY PROF. A. A. BRENEMAN.—The instrument consists of a glass tube, shaped as a small funnel at one extremity, bent once at a right angle a short distance beyond the funnel, and drawn out to one-fourth of its diameter for a length of an inch or more at one inch beyond the bend. The funnel is then covered with a piece of thin sheet rubber, securely bound over it. The tube is then filled with clean mercury to the lower part of the capillary portion. The covered funnel being held against the pulse at the wrist, receives the arterial impulse, which, acting upon the mercury, causes it to rise and fall in the capillary tube in time with the beating of the pulse. By the use of a pair of wires whose separated ends are connected at each upward leap of the mercurial column, an electric bell may be rung by the pulse. The use of photographic paper may permit the accurate delineation of the minor movements, which are only roughly apparent to the naked eye.

Prof. Newcomb suggested that now, by this means, the sick man could communicate the condition of his pulse to his doctor, who could thus feel the pulse of a patient

thousand of miles away, and of course telegraph in return a prescription. This suggestion excited a great deal of laughter. Prof. Newcomb spoke, however, with admiration of the simplicity and ingenuity of the invention.

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ACTION OF LACTIC ACID ON ANIMALS.

By C. Heitzmann.—Cats and dogs treated with lactic acid, whether administered in their food, or by subcutaneous injection, showed, after two weeks, swelling of the epiphyses of the long bones, catarrh, and other symptoms of rachitis. The bones on a microscopical examination presented the same appearance as those of children who had suffered from rachitis. If the lactic acid feeding is continued for a longer time, after about four months, softening of the bones occurs, and they have all the appearances of bones from cases of *mollities ossium*.

In rodents, this action does not appear to take place; for two rabbits and one squirrel, after respectively three, five, and eleven months' lactic acid feeding, showed no signs of rachitis. Many observers have found lactic acid in the urine of persons affiicted with rachitis, and Schmidt obtained it from the long bones in a case of softening of the bones.

BRAINS OF MEN AND ANIMALS.

At the recent meeting of the British Association, the Dean of Clonfert, Dr. Byrne, made a very praiseworthy attempt to trace to the anterior, middle, and posterior portions of the brain-hemispheres or cerebrum, the various mental faculties which we see successively developed in those lower animals most nearly akin to man. He pointed out that in the rabbit, dog, ape, and man, certain portions of the brain are relatively of larger development as we pass from the first to the last, and that accompanying this development we have the development of new psychical powers. In the rodents and ruminants there is first perceptible the power of thinking of a series of connected acts. In the carnivora there is a power of design, and in the anthropoid apes a sense of general principles. Cases were cited to support these propositions, and it was suggested, in accordance with the corresponding anatomical arrangements, that the anterior lobes of the cerebrum belong to the act of thinking of single objects, of sense; those of the middle lobe to the act of thinking of such objects, with a sense of their succession, and of each as a part of the succession; and those of the posterior lobe to the act of thinking of the co-existence or succession of them as a general principle.

BLISTERS IN RHEUMATISM.

THIS ancient treatment is returning to vogue in England. The blisters are generally made two or three inches wide, and long enough to encircle the limb. When they have risen, they are dressed with linseed meal poultices for several days. Usually, the patients do not complain of the blisters, nor is there any serious inconvenience from them; but as soon as the drawing is accomplished there is a marked amelioration in the swelling, pain, and constitutional disturbance. The cases most eligible for treatment by this means are those where several joints are involved, and the suffering and constitutional disturbance great. Three to six blisters are applied at once near the affected joints; they are repeated as exacerbations occur, and are applied to joints as they are successively involved. (112)

CHLORAL HYDRATE AND CAMPHOR.

IF chloral hydrate and camphor be rubbed together in a mortar, a rise of temperature is observed, and a syrup is obtained, which is neutral to test-papers, and does not give a precipitate with silver nitrate. On treatment with distilled water, it hardens to a white translucent solid; the chloral hydrate after some time appears to be dissolved out, leaving the camphor in crystalline grains. It is of great value as a local application in cases of neuralgia and toothache.

EFFECTS OF ASPARAGUS.

IN order to ascertain whether asparagine passed undecomposed through the system, A. Hilger used, during three days, a diet in which asparagus was the only nitrogenous constituent. The urine yielded a distillate possessing the characteristic smell which follows upon eating asparagus, but no volatile organic body could be isolated. Asparagine was entirely absent, but in its place comparatively large quantities of ammonium succinate. The amount of hippuric acid was considerably increased, and benzoic acid was also detected.

CEMENT FOR CHINA, GLASS, ETC.—To one ounce of gum-mastic add as much spirit of wine as will dissolve it. Soak one ounce of isinglass in water till it is quite soft; then dissolve it in pure rum or brandy till of the consistence of glue. To this add one-quarter ounce of gum-ammoniac well rubbed and mixed. Put now the two mixtures together in a vessel over a gentle heat till properly united, and the cement is ready for use. It must be kept in a phial well-stopped, and when about to be used, it ought to be set in boiling water to soften.

TROUT-CULTURE IN COLORADO.

PISCICULTURE.

THE AQUARIUM.

ONE of the first principles, in constructing a tank for an aquarium, is to give the water the greatest possible exposure to the air. The simple rectangular form is the best. This is generally constructed of iron and glass; the iron should be japanned, and the glass be French plate, to insure brilliancy and strength. The breadth and height of the tank should be about one-half of the length. Cheap tanks can be made of wood and glass, the frame and bottom being of wood, and the sides of glass. In order to make the joints water-tight, care must be taken to get a proper aquarium putty or cement. The following is a good recipe: Put an eggcupful oil and 4 ozs. tar to 1 lb. resin; melt over a gentle fire. Test it to see if it has the proper consistency when cooled; if it has not, heat longer or add more resin and tar. Pour the cement into the angles in a heated state, but not boiling hot, as it would crack the glass. The cement will be firm in a few minutes. Then tip the aquarium in a different position, and treat a second angle likewise, and so on. The cement does not poison the water. It is not advisable to make the aquarium of great depth; about eight inches of water is sufficient. In regard to the light, great care must be taken. Too much often causes blindness, and is a common source of disease. The light fish receive in rivers comes from above; and an aquarium should be constructed so as to form no exception to this rule. All cross lights should be carefully avoided, at least if the light is very strong. Never place the aquarium in front of a window so that the last passes through it; for, when viewing an aquarium, the source of light should come from behind us. Not enough light is as injurious as too much, and causes decay of the vegetation. Having constructed a water-tight aquarium, the bottom is strewn over with clean sand to the depth of 1 to 3 inches; on this a little gravel is spread; then a few stones or rock-work. Heavy large rocks should be avoided; they displace a large amount of water and increase the danger of breaking the glass sides. Pumice-stone, well washed, is the best kind, being light and with a rough surface suitable for the rooting of plants, etc.; and if fancy forms are desired (bridge-work, etc.), the pumice-stone can be cut quite easily to the desired shapes. The

plants are rooted in the sand and the vessel left at rest for a week for the plants to vegetate. The following plants will be found useful: *Utricularia inflata, uiricularia vulgaris, myriophyllum spicatum, anarcharis Canadensis,* and *hottonia inflata.*

In obtaining plants, procure all the roots and see that they are well rooted. If fungus should form, add snails *(planorbis trivolvis);* they will completely destroy it. After the plants are well started, add the shells and amphibious animals. The following shells will be found desirable: *Planorbis trivolvis, physa heterostrapha, unio complanatus.* Many shells are not needed. Snails act the part of scavengers; and where the different elements of an aquarium are rightly balanced, two or more snails will be found sufficient.

If amphibious animals are introduced, the rock-work must extend above the surface of the water, or a float of some kind must be substituted. It is impossible for them to live under water all the time, and they would die without some such arrangement.

The turtles claim first rank. The *enys punctata,* or spotted water-turtle, and the *chrysemys picta,* or painted water turtle, will be found to be the best for the aquarium, and should be procured when very young, as they are very destructive when old. The tritons *(triton tigrinus, triton niger),* the red salamander, the crayfish *(astacus Bartoni),* are all suitable, and present a very odd and yet a very natural look to the aquarium.

In selecting the fishes, there is no boundary to the number to be obtained, but experience has proved that comparatively a few only thrive in confinement. Among these, and the first, is the gold-fish. He can live for months without introduced food, and is, without comparison, the most hardy, standing remarkable changes in the temperature; and he is the most gaudy and attractive. A large number of the fishes prey upon each other, and will only do for the aquarium when in the young state. Among these may be mentioned *pomotis vulgaris,* or sun-fish, *esox reticulatus,* or common pickerel, and *perca florescens,* or yellow perch. The *leuciscus pygmæus,* or rock-fish, is a great addition, aud is found very plentifully in our streams. The *pimelodus atrarius,* or common black catfish, is another worthy of a place. So also is the *hydrargia diaphana,* or transparent minnow. But few fish can live in an aquarium; and the needless crowding together, so often seen, is very hurtful to health, and causes sound, strong fish in a short time to become weak and poor. The great difficulty in keeping an aquarium is to secure enough oxygen

for the fish. To a slight degree, it is the duty of the plants to supply this; but if too much vegetation be present, decomposition takes place and ruin follows. It has been demonstrated that only a small amount is necessary to absorb the carbonic acid given off by the fish and amphibians; consequently, if the water be daily aerated with a syringe, it will absorb an abundant supply of oxygen for the animal life, and the trouble arising from the decay of much vegetable matter will be lessened or altogether avoided.

FISH IN THE HOT SPRINGS OF NEVADA.

ABOUT 80 miles north of Elko, Nevada, on the north slope of Bull Run Mountain, which never loses its massive banks of snow, rises a small stream, formed by springs that furnish the purest and coldest water I ever drank. The stream, after running a distance of half a mile, is about 2 feet deep and about 6 feet wide on an average: at this point a succession of hot springs rise on the banks, and flow into the stream, increasing the volume of water about one-third. The water of the springs is so intensely hot that less than three seconds are consumed in boiling eggs in it. The creek above and below this point swarms with fine brook trout; and, strange as it may appear, to persons standing on the banks where the hot water is discharged into the brook and looking through the rising vapor, you can see hundreds of the fish swimming to and fro in the boiling element with as much indifference as though there were no hot water near.

This letter, if unaccompanied by an explanation, would undoubtedly pass for a Nevada fish story; but to satisfy the incredulous, I will give the result of my investigation, it being July when I visited the place. I took a common thermometer with me, which only registered to 130° Fahrenheit. A test of the water above the hot springs showed a mean temperature of 42°; fastening my thermometer to a pole, I immersed it above the influx of hot water; and keeping it as near the bottom as possible, I moved it gradually down stream. The result was a very low temperature at the bottom, gradually rising to 65° until I reached a point (a fourth of a mile down the stream) where the temperature became uniform throughout. This, it will be seen, shows that the hot water, having a specific gravity much less than the cold, retains its place on the surface, forming an upper intensely hot stratum, and leaving the lower water with its finny tribe undisturbed, and to all appearances swimming to and fro in one of Nature's caldrons.

This stream is one of the many that form the head

waters of the Columbia River; and to this point, over eighteen hundred miles from its mouth, in the spring and fall, the salt water salmon come in hundreds to spawn.

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FISHING BY MEANS OF EXPLOSIVES.

At a recent meeting of the California Academy of Sciences, Mr. A. W. Chase, of the U. S. Coast Survey, read a short paper on the capture of fish by the explosion of cartridges by means of fuses under water, which he has practiced with much success. He says: "I have found that the ordinary water-proof fuse will burn about one foot to every twenty-five seconds, and by experiment that a cartridge will explode in from four to six fathoms with from three to four inches of fuse. I have, however, made no exact experiment on the subject. The shock of the explosion is most severely felt downwards, as the resistance is greater; and the different varieties of sea fish found near the rocky shores of the islands, as a rule, being found on or near the bottom, it is desirable to explode your cartridge about midway between the surface of the water and the rocks beneath, as you thus reach both the deep-lying fish and those, like mackerel and smelt, which swim between."

The *modus operandi* adopted by Mr. Chase was to take a small skiff and row out to the kelp beds surrounding the island. "Here, in six or eight fathoms of water, the bottom is distinctly visible. When an unusually large school of fish would swim by, I would quietly light the fuse and drop the cartridge into the water gently. If the water was, say, eight fathoms deep, I would graduate the fuse for explosion at four. The cartridge would slowly sink—generally in a spiral—and a few bubbles of air or smoke rise to the surface. When the fire reached the fulminate of mercury, there would be a sudden white flash, then a quick, sharp detonation, the blow striking the bottom of the skiff as if some one had struck it with a hammer. Then, in a space of time varying from eight to ten minutes, every fish within a radius of forty or fifty yards would slowly come to the surface. Those within the immediate vicinity of the explosion, of course, were killed by bursting the bladder and injury to the large intestines, and had to be speared up from the bottom. Those, however, at a greater distance, would be simply stunned, and could be taken in with a net. Care should be taken to avoid touching those only slightly stunned until the net was fairly around them, as the slightest blow would arouse them from their torpor.

"I am now about to relate what will, perhaps, be called a

genuine 'fish story'; but as I have, in addition to my own, the testimony of my men to the fact, I give it as it occurred:

"I had brought up by an explosion a number of yellow bass fish, weighing about four pounds each. These are delicious in chowder, and so, instead of putting them in alcohol, I had them cleaned, which was done by scaling, removing the intestines, and cutting off the fins and tail. The head, however, still remained joined to the backbone. These fish, from the time they had been taken from the water up to the time of cleaning, remained apparently lifeless. Nor did the removal of the intestines arouse them. They were then taken up to the old barracks, where I was temporarily camped, and hung upon nails driven in the clapboards. Some little time after they had been thus disposed of, one of the men came in and asked me to go out to look at the fish. I did so, and found every individual bass slapping around in as lively a manner as if he had been freshly caught and hung up. They had, in fact, recovered from the explosion, and proceeded to die in the common fashion. I took one down and broke the backbone where it joined the head. Its struggles ceased instantly, thus showing that the vital force had been arrested in the nerve centres and brain at the time of the explosion, and, when the effect had passed away, that the fish had resumed a galvanic life. It was probably about half an hour from the time of explosion when this occurrence took place. I have not been able since, however, to secure the same result, although I must state that the only time since then that I have tried the experiment was on the Oregon coast, where I brought up a school of salmon, all of which were pickled for Agassiz. These fish were, however, too close to the explosion, as they wer killed outright."

TASMANIAN FISH CULTURE.

THE question in regard to the success of the experiment of transplanting salmon to Tasmania is apparently set at rest by the announcement of the capture on the 30th of December last of the genuine grilse, for which the government reward of twenty pounds sterling has been paid, and the specimen forwarded to England. For many years past large fish have been seen leaping in the Derwent River, but no one was able to catch them; and although believed to be salmon, the fact was not proved by more positive evidence.

The fish referred to weighed several pounds, and if a salmon, must have been hatched in the river, as it is many

years since any eggs were imported into Tasmania. There now appears to be little doubt that the descendants of eggs of salmon transported from England have actually bred in these waters, showing that the fish have a greater adaptability to climate than has been anticipated, the contrast in point of temperature in the surrounding seas being very decided. We have in this much encouragement for the measures taken to multiply salmon in regions of the United States where they have never grown naturally.

It is much to be desired that in any other experiments of the transfer of salmon to Australia the California fish be tried, not only on account of the greater certainty of their safe arrival, but from their better adaptability to the new locality.

MASSACHUSETTS FISH CULTURE.

THE protection and multiplication of fish have become a matter of national interest; and boards of fish commissioners are now appointed by the United States Government, and by fourteen several States. The Supreme Court of Massachusetts has sustained the claim of the commissioners regarding the falls created at Holyoke; and the Holyoke Company has been compelled to build fishways which will permit the passage of salmon. With similar ways at Turner's Falls in Greenfield, the Connecticut will again become a salmon-breeding river; and the commissioners are stocking its upper waters with fish, both *Salmo salar* and *Salmo quinnat*, which is the Sacramento salmon. Some salmon have been caught in Massachusetts Bay. They have saved the smelts in our bays and estuaries, so that they can again be caught with hook and line. The artificial arrangements for breeding trout in the State are increasing. An experiment toward the breeding of land-locked salmon has been begun. Twenty-six "great ponds" have been leased by the commissioners for the cultivation of useful fishes; and the propagation of black bass seems successful in these ponds.

PRESERVATION OF FISH BY FREEZING.

NEAR the city of New-York is a large and flourishing establishment for preserving the highest-priced fish-meats, such as salmon, by freezing.

The entire first floor forms a gigantic refrigerator, having double walls of zinc, and divided into three sections, in each of which are two compartments. Ice and salt, ground together in a mill, are introduced into the spaces between the walls through openings in the floor of the second story, these apertures being so arranged that any number of the compartments can be cooled without affect-

ing others. After the fish are cleaned they are placed in pans, the latter being piled above each other in layers, packed in ice and salt and covered up. Here the fish are left until thoroughly frozen, after whch they are thrown into the huge refrigerators where they are kept. Within these receptacles the temperature is maintained at about 12°, and the fish are consequently rendered about as hard as solid lumps of ice. In this condition they are kept ordinarily six months and sometimes for eleven months, remaining perfectly fresh, and only requiring thawing out to render them ready for cooking.

The fish are purchased in summer, when the supply is plentiful, and preserved until winter, when a large advance on the cost is realized.

ENGLISH FISH-CULTURE IN INDIA.

IN December, 1867, Mr. McIvor, Superintendent of the Chinchona Plantations, on the Nilghiri Hills, in Southern India, took out carp, tench, trout, and other fish, with which he has now stocked the rivers, streams, and lakes, of the Nilghiris. Thc trout have not succeeded well, but the growth and increase of the tench have been marvelous. The first English fish were put in the lake at Utakamund, in August, 1869. In 1871 and 1872 the streams flowing into the lake were well stocked with fish, and for the last few months they have been caught in large numbers by the natives, and sold in the markets. The tench greatly predominate. One interesting fact is that many European fish have been caught below the great Kalhutty water-fall, showing that they have survived after being carried down the highest fall from the Nilghiris, in the descent of the Utakamund Lake and River to the plains. It may, therefore, be expected that the rivers, from the foot of the hills to the sea, will eventually be stocked with English tench.

PRIVATE FISH-CULTURE.

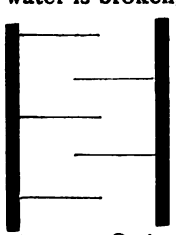
ONE of the principal causes why fish culture is not undertaken by persons of moderate means, is the supposition that large ponds or rivers are necessary to a successful business. A farm, however, of fifteen or twenty acres, with a small pond or two, natural or artificial, supplied with water from a river or from perennial springs, would be all that could be desired. Many kinds of fish, and especially leeches, may be raised with considerable profit. Of leeches we now import nearly two millions annually from Europe, at a cost of $100,000. One locality, especially well adapted by Nature for the business, is on the east side of the Passaic river, opposite the Newark water

works. on land sloping to the river. Besides dwellings, outhouses, barns, orchards, etc., there are two ponds supplied with never-failing springs of sweet water, and the bottom is the right kind for trout, crayfish, or leeches. The Passaic river would furnish food in abundance for the young fish. A place having so many natural advantages will probably be utilized.

One reason for mentioning the subject of raising leeches is that the supply from all parts of Europe, except Brittany, is gradually failing, because of the draining of the marshes of the Danube in Sclavonia and European Turkey, all native places of the leech. (25)

A GOOD SALMON LADDER.

THERE is a salmon ladder on the Tete-a-gouche River, near Bathurst, New-Brunswick, which is a complete success. This stream had been obstructed by a mill-dam about 30 feet high, for twenty years or more, and salmon had almost ceased to frequent the scanty two or three miles of lower river left them; a few did continne to run up from tide water this short distance, to the foot of the dam. The fishway (now about four years old, costing about $200, and constructed of heavy beams and plank), sloping at about an angle of 45° into the pool below the dam, is about 6 feet wide, 4 feet deep, and the descent of water is broken, as usual, by barriers, thus:



On the apron of the dam, at the head of this fish ladder, is a reception house, ten feet square, six feet deep, high enough to admit a man, and with a sliding barrel-gate at the entrance, and another at the upper end. The water is let into the fish-way only at night, and on each morning, after counting the fish which may have ascended during the darkness, the miller lifts the gate and the salmon pop on up stream. Owing to the smallness of the river above, the inhabitants were, at first, able to kill many of the new-comers; and so no salmon are allowed to run up until the September floods, which raise the upper stream and its pools so that the fish can not be easily got at.

The plan of detaining the fish until the autumn floods, in the short distance below the dam, where they can be so easily protected by the local guardian, instead of scattering them for fifty miles up river, to be killed by the settlers in every pool where low water in summer may have caused them to congregate, is a good one, for small rivers especially. (119)

LAND-LOCKED SALMON.

RECENT experiments with this fish have proved that it can be reared in ponds the same as trout, and that it "strips" as readily as any of its family. The result of a short investigation proves that the milt of one male is sufficient to impregnate the eggs of four or five females, and that the larger portion of the young are likely to be hatched out early in spring if the water is kept at a fair temperature. If the water is too cold they will not appear before March, but by increasing the temperature, which is usually 32° Fahr., to 35°, they will present themselves a month sooner. These pretty creatures, when hatched in ponds and fed regularly, do not manifest any uneasiness about their confinement; but the old ones, which are inclosed when they enter the fishways, almost always die if they are not allowed to make their escape when they have deposited their spawn.

This fish will live in water having a temperature of 70°, but if kept in ponds there should be scope enough for them to play about freely, and the water should have depth enough to give them an abundance of oxygen.

The best time to impound them is about the first of August, as they are then in good condition, and being well filled with ova, their instinct of maternity is very strong, so that they will thrive in places which under other circumstances would prove most disagreeable to them.

They will live on excellent terms with the black bass, so those who have ponds containing the latter should by all means try to give them the former for companions, as it is presumed that both thrive better by this companionship.

If the land-locked salmon can be cultivated to a large extent in ponds, it will be a most important step in fish-culture.

BROOK-TROUT.

A. PALMER, Boscobel, Wis., says: While this is not the fish for the million, as the amount which can be raised is limited, yet it is a greaf favorite with the angler and epicure, and is better adapted to cultivation in private ponds than any other fish yet experimented with. Although naturally very wild, it is easily domesticated, and with a little petting becomes as tame as a kitten.

They are easily bred, and grow rapidly, although they don't produce as much spawn as some fish, yet a sufficient amount to trouble the breeder to find water to raise the fish in, each female producing from five to eight hundred spawn at two years old; and about double that number at

three years old; but they can not be raised to advantage in any other than spring or brook water. This may be either hard or soft, but not largely impregnated with minerals.

Trout, in their natural state, prefer active water of even temperature, but still they do well in pond water if there is a continual supply of fresh water running into them, and will stand a temperature of sixty-five or seventy degrees; but water which runs up to a high temperature will not raise as many trout as that of more even temperature. The same applies to still water. They are great consumers of oxygen, and cold water contains more than warm water, and running water more than pond water. In building ponds we try to have a fall from one pond to another to carry this property into the water. We find in transporting trout that as long as the cars are moving they need but little attention, but if they stop for a short time the water must be agitated.

They are cheaply raised. Being cold-blooded, they waste no food in keeping up the heat of the body, and ponds which have been built a few years, as well as brooks, produce a large amount of insects and crustacea, and nearly enough to feed what trout the water will bear.

I am feeding about fifty thousand, ranging from two to eighteen inches in length, the larger portions small, and they will not eat a beef liver a day. Milk curds, any lean meat that is fresh, or other kinds of fish, make good food for them.

In connection with other farming, a small spring that is perpetual will pay to improve, while many farms in the State contain water enough to raise more pounds of meat than all the arable land would, if cultivated, and the produce of it fed to cattle and hogs, and the building of the ponds would not cost as much as the necessary buildings to make the stock comfortable.

TROUT-CULTURE IN COLORADO.

TROUT culture begins already to be a large industry in Colorado, and it is believed that in a few years that region will be able to furnish the Eastern markets with an immense supply of this delicious fish.

The pure water of the mountain streams is found to be admirably adapted to the purpose.

Our engraving gives a view of the interior of a trout-hatching house on one of the Colorado streams. It does not differ in any material detail from similar establishments in other parts of the country. The spawn is deposited in long troughs, slightly inclined, through

which runs a constant stream of pure spring water. When the young fish attain a certain growth they are placed in ponds arranged in a series. In the first they remain three or four months, after which they are transferred to a second, and so on from one to another until they have attained their full growth.

STOCKING STREAMS WITH TROUT.

A WISCONSIN farmer writes to the *Western Farmer* as follows, and makes a suggestion we think worth heeding: "A year ago, having more young trout than my pond would accommodate, I put a few thousand into a barren stream near me. They were then about one inch long. A few days since I thought I would see what they had done. I took my rod and a couple of my little boys and went to the branch, and in less than an hour caught thirty, all we wanted, and might have caught hundreds, as we could see them in schools of fifty or a hundred in a place, for a mile up and down the brook. They were about seven inches long, and those left by midsummer will be nine or ten inches long, or what would be called a nice catch.

"As this same thing can be done by every brook of pure water (either hard or soft) in the State, I submit if it would not pay the owners of brooks to stock them, if in nothing else, in furnishing one more attraction for the farm. If not for themselves, for the boys, for recreation is as necessary to them as meat and bread, and if they can't find it on the farm they will hunt it in the village."

FISH-FARMING.

I HAVE kept trout at a temperature above 60°, in fact, as high as 75°, where there was a good flow, and consequently a rapid change. Don't dam a ravine for a pond; the wind will blow leaves in, which, with the leaves and drift brought down by rains, will clog the screens, and the floods will carry everything away. If you dam the ravine, do it high up, and lead the water in a ditch along the hillside into ponds, and let all floods and surface-water go over the dam and down in the old channel. "Spring water can not be too cold for trout," says our correspondent. I believed this a few years ago, but find that trout kept at the head of my spring, where the temperature is 49°, do not grow much, while those kept below, where it is 60° and 65°, grow rapidly, and trout fry, if left free, will work down where the water is even warmer. Black bass, pickerel and perch are recommended where the water is too warm for trout, but these fish are all cannibals: the first-named is good for the table and the sportsman; the second is a gormandizing beast, unfit to associate with decent fishes, and only

eatable when nothing better can be had; the third is a good little pan-fish, but terribly destructive to other fish. If I were asked for a list of fishes to be kept in waters not suitable for trout or grayling, it would comprise white-fish, ciscoes, smelts, the large carp of Europe, and the square-tailed variety of catfish that is known in the Eastern States as a bull-head, hornpout, etc. The indiscriminate introduction of predaceous fishes to please the sportsman has been carried too far, and many waters are filled with them that will be wanted for a more peaceable and prolific fish in a few years.—*Fred. Mather.* (25)

TROUT-CULTURE.

As the average duration of a trout's life, says Mr. A. S. Collins, is not more than one-third of the average duration of human life, we may expect that about three times as many trout as human beings will die in the course of a year. This is a natural and unavoidable loss. But when the loss rises much above the average, or when something like an epidemic breaks out among them, we may be sure that something is wrong, and experience teaches that the loss can almost always be avoided.

As a general thing, neither a fish nor any other animal will eat improper food. Brook trout are carnivorous, and any kind of flesh will do for food. If they eat it, take it greedily, and get fat upon it, it is proper food. Any one used to fish can tell in five seconds whether the trout are hungry or not. If the trout are not sized off properly, but large ones kept with the smaller, then the big trout will drive away the small ones and keep them from eating.

Sometimes, indeed often, the trout are not fed enough, or are fed only at long intervals. In any of these cases the trout lose their plump appearance, and begin to show a disproportionate size of head. The appearance of the fish should be noted every day, and the first signs of decrease in weight should be the alarm for increased care in feeding. The food ought to be chopped fine, and not in strings or crumbs. It should be given often and to repletion, that the large and well, being gorged, may allow the small and weak a chance to make a good meal.

Far more often the undue loss is owing to an insufficient supply of water, or rather, to an insufficient supply of air. Persons making ponds forget, first, that the volume of water furnished by a spring is never so large in the summer or early fall as in the spring of the year; and second, that even if the volume should be the same, the quantity of air held in any given flow of water in summer is very much less than that held in the same flow in

winter. For a familiar illustration, it is a well-known fact that a pound of trout will live in a bucket of water in winter, out of doors, for half a day or more, while they would not live a half hour in the same quantity of water in summer.

It is not very hard to tell when the fish are suffering from air. It is only during warm weather that the breeder need watch for this mischance, if he has only been moderately prudent in stocking his ponds. If the water is getting too warm, or, in other words, if the air in it is getting too small in quantity for the number of fish, a few will be found dead, perhaps, without any mark upon them, being to all appearance plump and healthy. Fungus will show itself upon some, and some will turn dark in color. A few may be found upon the grass, near the entrance of the water, if the banks are low. Their appetites may not be visibly affected at once, but will soon begin to disappear, and the fish die "by hundreds." The only remedy is to give them more water, or take out a quantity of fish, and even this is not a remedy unless done at the very start, for even with an increased flow of water the fish will keep dying for a long time. I believe that more brook trout have been lost in ponds by overcrowding than from all other causes put together. It must be borne in mind that overcrowding has reference to the flow of water, and not to the size of the pond. A tank ten feet by twenty may be overcrowded, or rather overstocked with fifty pounds of fish, and again, it may comfortably support two hundred pounds or more. Cold water and plenty of it, is the motto of the brook-trout. (119)

LONGEVITY OF FISHES.

Dr. BUCHNER, of Giessen, presents to the Dorpat Natural History Society his contribution to the facts bearing upon the longevity of fishes, in which he remarks that a large eel is now living in a stone trough about ten feet long, with a board top, through which is continually running a stream of cold water. The eel has been kept in that trough for twenty-six years, and now measures nearly five feet in length, the weight about a year and a half ago being four and a half kilogrammes. The length of the fish when placed in the trough is not known, but its weight was one and a quarter kilogrammes. It was estimated to be about eight years of age at that time, and consequently would now be thirty-four. The food of this animal consists of small trout, of chopped liver, and of coagulated blood.

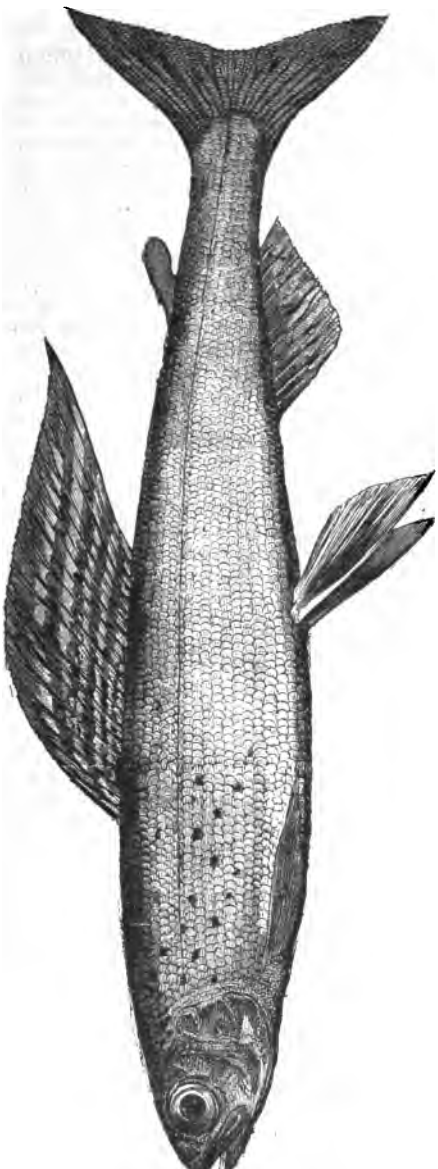
THE MICHIGAN GRAYLING.

As there has been a great deal of interest manifested in this fish, we give an engraving taken from life, kindly furnished to us by the publisher of *Forest and Stream*, in which it recently appeared. The exact size of the fish was ten inches. Professor Milner thus writes of the grayling: "There is no species sought for by anglers that surpasses the grayling in beauty. They are more elegantly formed than the trout, and their great dorsal fin is a superb mark of beauty. When the well-lids were lifted, and the sun-rays admitted, lighting up the delicate olive brown tints of the back and sides, the bluish white of the abdomen, and the mingling of tints of rose, pale blue, and purplish pink on the fins, it displayed a combination of living colors that is equaled by no fish outside of the tropics."

Mr. F. Mather says: "The grayling has all the fins of a trout; his pectorals are olive-brown, with a bluish cast at the end (I am describing him as I saw him in the water in my ponds an hour ago), the ventrals are large and beautifully striped with alternate streaks of brown and pink, the anal is plain brown, the caudal is very forked and plain, while the crowning glory is its immense dorsal; this fin rises forward of the middle of its back, and in a fish a foot long it will be nearly three inches in length by two high, having a graceful curved outline, and from eighteen to twenty rays dotted with large red or bluish purple spots, which in life are brilliant, and are surrounded with a splendid emerald green, which fades after death; it does not seem as if this green could be represented by the painter's art; it is that changeable shade seen in the tail of the peacock.

"In shape the fish is like a trout, a trifle slimmer, perhaps, and not so thick near the tail, but the fin on the back of a trout looks so small and square, so deficient in outline and color, after beholding the graceful curve of a grayling's dorsal. The scale is large, silvery, with sometimes a copper tinge; near the shoulders there are black spots, sometimes triangular, and at others V-shaped; in some fish these extend nearly to the tail near the back; they are in lines which gradually shorten towards the belly; the mouth is small (nearly square when opened), and the teeth are merely a slight roughness on the lips, none on the tongue. But you want to see him come in on a line, with his fins all standing, and your eye will then give you a better idea than all the cold-blooded descriptions could ever do.

"The eye of the grayling is large and full, with a beauti-



THE MICHIGAN GRAYLING.—(THYMALLUS TRICOLOR.)

ful yellow iris, and when I wrote 'the tail is forked and plain,' I had not observed its pinkish edge, nor the changeable, metallic-green lustre that it shows in some lights, which is more like that seen in silk. A glint of the same is also observable on the second dorsal. Many letters have asked the question: 'Is this fish as handsome as the trout?' And in answer I will say, yes to some eyes, while to others it may not be. Seen from above it does not appear so, as the pink and white of the trout fins are more showy. The form of the grayling is more graceful than the trout's, and the head is beautiful, while the side of the trout and its lower fins are more gorgeous than those of the grayling. The trout has not a handsome head to my eye; the lines are hard, and there is an expression of savageness in the jaws."

We call particular attention to the marks on the fish. They will be found to be arranged in a certain positive order, running in accurate diagonals from left to right. What Mr. Mather calls "the crowning glory of the grayling," is its immense dorsal, which streams out like a pennon on a lance. The curious adipose fin which marks it as one of the salmonidæ is clearly shown. We trust soon to be able to give the distinguishing traits between our native fish and the English grayling. (119)

BLACK-BASS CULTURE.

GREAT progress has been made in the last five years in the distribution of the black-bass, especially in New-York and in the New-England States. Two hundred or more ponds and lakes have been stocked, and yet we are continually receiving letters of inquiry, which show that people have very imperfect information in regard to the habits of the fish, and the best method of introducing them. Some inquire for the spawn, supposing that they are propagated like the salmonidæ. But all attempts to take spawn from this fish have been failures, so far as we are informed. Some ponds have been stocked with the fry, but it remains to be seen whether this will prove successful. The fry are very small, and remain but a few days over the beds where they are hatched, so that it requires very close watching to capture them. They are removed just at the time when they are said to have the protection of the parent fish, and they are all liable to perish in new water among other species of fish. The common and the most reliable method of introducing the bass, is to transport adult fish from well-stocked ponds to new localities. This, when properly done, has never been known to fail. In most of the States there is legal protection to the fish for three years, generally granted by special act of the

legislature. But this is not long enough to secure the object. It should be in all cases five years. The fish do not bite freely until after the spawning is over in May and June, and they do not usually reach their new home until July or later, so that there is no fry from them until the second year. The fish generally selected for transfer are from one to three years old, measuring from three to twelve inches in length. Fish of this size are not only more numerous, but they bear transportation better, and are more readily acclimated, than when larger. They are moved with a good deal of difficulty in hot weather, especially when the journey requires more than twelve or fifteen hours. With the most skillful management, there will be a considerable loss. In the fall months there is much less loss.

The bass wants clear, lively water with rocky or gravelly bottom, and the more of it the better. It wants room for itself and for the poorer kinds of fish upon which it feeds voraciously. It does well in the mill-ponds upon manufacturing streams, and if the head waters and reservoirs are stocked, they will in a few years be found in all the waters below. They flourish also in natural ponds of twenty acres or more. Some decline to stock these ponds or lakes because they are generally free to the public. But this is short-sighted policy. A large pond or lake stocked at a cost of one or two hundred dollars, and protected by law for five years, will furnish better sport to the gentlemen or company who undertake the enterprise than they could find in any small pond of their own. In suitable water black-bass multiply very fast, and after they once gain possession, their numbers can never be very seriously reduced by hook fishing. The annual spawning will more than keep up the supply. There are thousands of ponds and lakes in the Northern and Middle States of from one hundred to a thousand acres, producing only the poorer kinds of fish, that might easily be stocked with bass, and add largely to the food supply of the people. (71)

THE BASKING SHARK.

PROFESSOR MACALISTER gave an account, before the British Association, of a large basking-shark *(Selache maxima)* lately examined by him, and he referred to the recently-established fact of its entire absence of ferocity, and to its feeding on small crustaceans, which are caught by taking them into the mouth and forcing the water through whalebone-like strainers, between the gill arches, composed of true dentine, and which prevent the food from escaping between the gill slits.

NEW OYSTER PARASITE.

IN a paper read before the Boston Society of Natural History, Professor John McCrady treated of the food and reproductive organs of the oyster, with an account of a new parasite, as observed in oysters taken in Charlestown Harbor. The oyster lives in the mud bottom, imbedded in a thick layer of low organic forms which cover the whole surface of the mud as a yellowish organic film. The upper portion of this growth is tenanted by diatoms, sporules of algæ, and by rhizopods, of which the former two, at least, seem to form the principal food of the oyster.

In the reprodnctive organ of these oysters a peculiar entozoon was found, which, in the most advanced stage, is branched, with two long tentacle-like organs at one extremity. This parasite appears completely to destroy for a time the fertility of the oyster; and to its abundance may perhaps be due the seasons of short spawn often noticed by those engaged in oyster-culture. This parasite has been named *Bucephalus cuculus*.

HATCHING FISH IN TRANSIT.

F. MATHER, of the U. S. Fish Commission, has invented a can in which to hatch shad eggs while traveling. It consists of one small can inside a large one. The small one has eight arms terminating in rubber balls, which press against the outer can and allow it to slide up and down as required to get any depth of immersion, and yet will hold it in any desired position. The bottom of the interior can is of wire cloth, and there are places for one or more trays of the same material above it. There is a four-inch space between the cans, and the motion of the surface-water while the cars are running is expected to agitate the water below the wire sufficiently to cause a proper amount of circulation, and to agitate the eggs. When there is but little motion the interior can is raised, to bring the eggs up near the surface, where the greatest agitation is found, and when the train is at a higher rate of speed it is lowered.

MR. C. G. ATKINS, of Bucksport, employed by the United States and Maine, Massachusetts, Vermont, Rhode Island and Connecticut, to collect the eggs of fish, has at present in his building, erected for the purpose (28x70 feet in size), about 2,500,000 eggs obtained from 500 salmon. The estimated number of eggs obtained from each female fish is about 9,000, of which about 8,000 mature under favorable circumstances.

CALIFORNIA OYSTER-CULTURE.

AT a recent meeting of the California Academy of Sciences, a member submitted for inspection shells of oysters transplanted from the Atlantic coast. These were covered with the spat of young oysters. It was a question whether the spat was that of the native California oyster, or the product of the transplanted bivalve, and oystermen whom he had consulted were unable to determine the point. Mr. Throckmorton, State Commissioner of Fisheries, stated that he had investigated the matter, and found that the spat was the product of the California oyster. It was found on the shells of Eastern oysters only where they had been transplanted in the vicinity of native beds. As yet the Eastern oysters had developed no tendency to increase in Pacific waters. They were short-lived there, becoming very fat, and dying within a year after being placed in the Bay of San Francisco. The experiment of transplanting Eastern oysters must therefore be deemed a failure.

THE STRUGGLE FOR EXISTENCE.

MR. BUCKLAND recently fought a pitched battle in the Round Pond, Kensington Gardens, with the innumerable hosts of a crustacean parasite that was destroying the fishes. Having learned that there was something wrong at the pond, Mr. Buckland went there to make a reconnoissance, and found, at one point, some little distance from the bank, a dense "cloud of fish." Having waded into the midst of them, he discovered that the supply-pipe, through which fresh water was admitted to the pond, was nearly choked up. The fish wanted fresh water, evidently. He took up with a landing net one or two of those that were most sickly, and found them literally covered with parasites. Various means were tried for removing the parasites, the most expeditious way being the use of a stiff brush, with sand. Having thus taken out of the pond, cleaned, and returned again to the water many hundred fish, it was discovered that the labor was in vain, for the parasites were so numerous that soon the fishes were infested again. The crustaceans plainly were holding their own. Mr. Buckland now cleared away the mud in front of the pipe, so that the fish might have a chance of rubbing off their tormentors against the bottom. He next conceived the idea of spreading a quantity of gravel about the pipe. With the aid of this and an abundant supply of fresh water at a low temperature, the fish were enabled to rid themselves of their parasites easily, and in the cooler water the latter did not find the conditions of life so favorable.

TROUT IN AN ARTESIAN WELL.

MR. BARD, the agent of the California Petroleum Company at San Buenaventura, was lately engaged in constructing a wharf at a point southeast of that place. Wanting water to supply this wharf, he commenced sinking an artesian well on the sea beach, not 5 feet from high water mark. At the depth of 143 feet a strong flow of water was obtained, which spouted forth to a height of 30 feet. It was controlled with a "goose neck," and utilized. One day, while the agent was absent, the men round the well noticed fish in the waste water. On his return they called his attention to the fact, and on examination the well was found to be filled with young trout, thousands of them being thrown out at every jet. These trout were all the same size (about two inches long), and perfectly developed. The eyes were found perfect. Now there is no stream nearer than the Santa Clara river, several miles distant. Could these fish, then, it is asked, have come from its head waters by some subterranean outlet? There are no trout in the lower portions of the stream. The temperature of the well water is 64° Fahr. (7)

TREATMENT OF GOLD-FISH.

SETH GREEN says this as to the proper care and treatment of gold-fish: "Never take the fish in your hand. If the aquarium needs cleaning, make a net of mosquito netting and take the fish out in it. There are many gold-fish killed by handling. Keep your aquarium clean, so that the water looks as clear as crystal. Watch the fish a little, and you will find out when they are all right. Feed them all they will eat and anything they will eat—worms, meat, fish wafer, or fish spawn. Take great care that you take all that they do not eat out of the aquarium; any decayed meat or vegetable in water has the same smell to fish that it has to you in air. If your gold-fish die, it is attributable, as a rule, to one of three causes—handling, starvation, or bad water."

CONNECTICUT SHAD-CULTURE.

THE number of shad annually running in the Connecticut River has increased to such an extent that the complaint of the fishermen is no longer of a *paucity* of fish; but the market is so overstocked, that they do not obtain a remunerative price for them. The desire and intent of the commissioners are to make shad so abundant, that the poor man with his quarter of a dollar may obtain as good a fish as three or four years since readily commanded a dollar and twenty-five cents per pound.

FOOD OF SHAD.

As a general rule, the stomachs of shad when taken in nets during their spring migration very rarely contain food of any kind, and it is therefore somewhat difficult to determine of what their sustenance consists. However, Mr. Elwood R. Norny, of Philadelphia, while attending his shad and bass fishery, at the head of Delaware Bay, near Fort Penn, noticed that one of the shad was unusually distended, and on opening it found the stomach crammed to repletion with a small crustacean, which from his description is probably a species of *Mysis*. Dr. Leidy also records an instance where a shad taken in Delaware Bay in the fall had several fish in its stomach.

ARTIFICIAL BREEDING OF TERRAPIN.

AN establishment has lately been started near New-York city for this purpose, and appears to be very successful. The animals are caught at various points along our southern sea-coast, and placed in a huge pen built on the beach near Long Branch, N. J. About two-thirds of the inclosure is under water, and the bottom is sloping, so as to have a depth of some eight feet in the deepest part. As many as ten thousand terrapin are placed in this receptacle at a time. Large numbers of eggs are laid on the unsubmerged sand, but one terrapin would quickly destroy and devour the eggs of another, while the young ones were sure to be killed as soon as they appeared. In order to supply an artificial breeding-place where the eggs could remain undisturbed, another pen has recently been constructed. Every day the surface of the pen is raked, and the eggs, carefully removed, transplanted in the new inclosure in regular rows, at a depth about equal the length of a good-sized terrapin's body. As many as 5,000 eggs were thus placed at one time during the past summer, and left to hatch by the warmth of the sun. In due time the young terrapin began to appear; and all seemed to be healthy and doing well.

WHITEFISH BREEDING.

THE experiments of Mr. Nelson W. Clark, of Clarkston, Mich., have resulted in proving that this inhabitant of the deeper lakes and rivers can be successfully propagated artificially. He has become convinced that spring water will not do for whitefish. He fixed a pond in which to place eggs, and which could be allowed to freeze over and remain so all winter, thus keeping the water so cool that incubation would be gradual. He succeeded thus in hatching the greater number of the eggs, but the young fish died when fed with any food (artificial) that he could procure. The next year, about April 1, four and a half months after taking the eggs, the young fry were put

into the Detroit river and into three small lakes in Oakland county.

Mr. Clark is certain that he can succeed every time if he can keep the water, in which are the eggs, covered with ice until April 1; and he is equally certain that the eggs of the salmon, salmon-trout and brook-trout should be hatched in running spring-water. Their eggs hatch about February 1, and the young have an umbilical sac attached to them, from which they derive all their sustenance for about fifty days. Until this sac is absorbed they require no artificial food, and after feeding them a few days they can be turned out in a pond to take care of themselves. But the whitefish when first hatched have no yolk sac left, and for some reason or other artificial food kills them every time. They must therefore be retarded from hatching until Spring, so that they can immediately be turned out.

None of the fish put into the lakes in Oakland county in 1872, had been seen until November 17, 1873, when they were found in apparently countless numbers in one of these lakes. A single boat-load of fishermen took 250 in an hour with spears—400 or 500 being taken a few days afterward in the same place. These were all whitefish of fair size for the table.

Mr. Clark is much to be commended for his perseverance in his attempts to restock our fresh water lakes with a fish which is so staple an article of commerce. The whitefish (*Coregonus albus*) is one of the salmon family, and is the principal fish caught for export in the waters of Lake Erie, Detroit River, and the straits at the lower ends of Lakes Michigan and Superior. Owing to the constant demand for this fish, it has been so relentlessly hunted that the average yearly catch has fallen off nearly one-half. It is to be hoped that Mr. Clark's success may induce the general artificial propagation of one of our great sources of animal food.

CURIOUS EGG NEST.

It is an interesting fact in the economy of certain fishes, especially of those belonging to the family of the Siluridæ, that the mouth constitutes the nest for hatching the eggs, these to the very limited number of from five to twenty being kept in this cavity, usually that of the male, until they are hatched. They are probably caught up after exclusion and fertilization, and retained. Some of these eggs are half an inch in diameter. The fact of this peculiarity in the case of the genus *Arius* and some of its allies in America has long been known; and Dr. Day announces the same condition in certain Indian species of *Arius* and *Osteogeonisus*.

THE NERFLING.

AMONG the species of fishes more recently suggested as suitable for introduction into fish ponds, is one known as the "aland" or "nerfling." Its usual size is about twelve inches, but it sometimes attains the length of eighteen or twenty, with a weight of six pounds. The typical species is colored very much like the ordinary chubs and minnows of American waters. A reddish variety, with colors as brilliant as those of the gold-fish, has been cultivated for a long time in Bavaria, where it is known as "orfee," and was called by Linnæus *Cyprinus orfus*.

The species is now in great request as an ornamental fish for ponds, in consequence of its habit of swimming in schools on the surface of the water, and thus being almost always in sight. It has been lately been introduced into England by Lord Arthur Russell, and has been placed in a lake at Woburn Abbey, from which it is probable that it will be distributed into other portions of the United Kingdom.

A writer in the London *Field* remarks, in reference to this fish, that it forms a parallel to the gold-fish of China, which in its typical form is by no means golden, but olivaceous and silvery, and that the redness represents a peculiar form of albanism, which has become permanent.

NEW WHALING GROUNDS.

THE two arctic whalers, Capt. David Gray, of the "Eclipse," and Capt. John Gray, in view of the diminution of whales in the arctic seas, have lately turned their attention to the Antarctic Ocean, and have come to the conclusion that whales of a species similar to the right-whale, or Greenland whale, exist in great numbers in the vicinity of the south pole, and that the establishment of a whale fishery within that area would be attended with profitable results. They accordingly propose to leave Peterhead in August for that portion of the antarctic area lying between the meridian of Greenwich and ninety degrees west, as being the locality promising the most valuable results. This ground they are to reach in the end of October, and the fishery is to be prosecuted during the four following months, the vessels returning in May. The distance does not exceed 7,200 miles from Great Britain, or a two months' easy passage. They recommend the use of two steamers of 800 tons and 120 horse-power.

NATURAL HISTORY AND ZOOLOGY.

THE WARREN MUSEUM.

THE rarest collections of scientific relics are often the most unvisited, and it is a somewhat singular fact, that the choicest and most instructive curiosities in many of our larger cities are not to be found in the popular museums. Thousands of people living in the city of Boston, who are familiar with the stuffed animals and astonishing wax figures in the old Boston Museum, and are accustomed to air their fancy among the respectable fossils and gorgeous tropical birds in the Museum of Natural History, have perhaps never so much as heard of the wonder-exciting collection of anatomical curiosities known as the Warren Museum. The building stands on Chestnut Street, a quiet, tenantless alley, running from Charles Street to the Charles River, but a few steps from Beacon Street and the Public Garden. It is made of brick, with heavy iron doors and shutters, and of all places would be the least likely to attract the eye of the stranger, but for the inscription over the door—"Erected by Dr. John Collins Warren."

Dr. John Collins Warren was the son of Dr. John Warren, a most skillful surgeon in the American army during the Revolutionary War, and the founder of the medical school in Harvard College. He was educated in the best medical schools of London and Paris, and, on the death of his father, in 1815, was elected Professor of Anatomy and Surgery at Harvard College, and in 1820 was placed at the head of the surgical department of the Massachusetts General Hospital, a position that he held for thirty-three years. During the latter period he made the most extensive collection of anatomical specimens to be found in the country. A part of these are still at the Massachusetts General Hospital, a part at the Boston Museum of Natural History, and a part, comprising the rarest and most valuable, constitute the Warren Museum.

The museum belongs to Dr. Warren's heirs. For a considerable period after his decease, they used to open it on certain days to the public, but it ceased to excite curiosity, and is now only opened by special permission, on application to members of the family. Every courtesy is extended to those who wish to visit the place for scientific pur-

poses, although no provision was made in Dr. Warren's will for the preservation of the relics or care of the building.

The curiosities collected by Dr. Warren, which are to be seen in the Boston Museum of Natural History, are comparatively unimportant. The biography of the highwayman, Walton, bound in his own skin, attracts the lovers of sensation, and the cast of the French horned lady, and the skeletons of certain rickety Indians, seem to be particularly appetizing to children. The anatomical specimens, showing how near a person may come to death, and yet escape, are, however, interesting. Among these is the cranium of the once famous Vermonter, who lived twelve years and a half after the passage of an iron bar through his head, the consequence of an accident in blasting rocks. He used to travel about New England, exhibiting himself and his bar. He died in California about the year 1860. The bar was three feet seven inches in length, and 1¼ inches in diameter, and weighed 13¼ pounds. It is placed near the cranium, in the Museum.

The Warren Museum consists of two fire-proof rooms, one of which contains gigantic fossils, aud the other, relics which the great anatomist wished to preserve with more than ordinary care. Among these are the skull, brain and heart of Spurzheim, the phrenologist and anatomist, who died in Boston in 1832, and whose monument graces one of of the principal avenues of Mount Auburn.

Spurzheim was a martyr to science, and those who were familiar with his self-forgetful life, and the vicissitudes of his career, could hardly view these relics with unmoistened eyes. The heart is preserved in a glass jar of alcohol, and the brain in a glass box filled with liquid. The Prussian philosopher died only two months after his arrival in Boston, during the delivery of his first course of lectures. He gave his body to science, to which, from boyhood, he had devoted all the energies of his soul.

The most remarkable object in the Warren Museum is the largest skeleton of the *Mastodon giganteus* ever discovered on the continent. By its side, in way of contrast, is the frame of the elephant Pizarro, the largest ever brought to this country. The skeleton of the *Mastodon giganteus* will not fail to cause the visitor to start back in awe, and he will be hardly able to suppress that adjective of fools, "Impossible!" It is twelve feet high and thirty-four feet in length, from the tips of the tusks to the extremity of its tail. Its trunk is seventeen feet in length. The animal must have weighed more than 20,000 pounds! It was found in 1845, near Newburg, N. Y. (77)

ANIMAL LIFE IN CAVES.

PROF. A. S. PACKARD, Jr., was recently engaged with Mr. T. G. Sanborn in exploring the caves of Kentucky, under the auspices of the Geological Survey of that State, Professor Shaler accompanying Professor Packard. They first examined the Mammoth Cave, and doubled the number of animals known to exist therein, and in others adjoining. An exploration, with Professor Shaler, of the Carter Caves, in Grayson County, Ky., also revealed a rich fauna, composed of 20 species. Professor Packard also examined Wyandotte Cave alone, and found a wingless *Procus* and two species of *Thysanura* new to the cave. Several caves within sixteen miles of New-Albany, Ind., at Bradford, were examined. Finally, a careful examination of Weyer's Cave, in Virginia, and the adjoining Cave of the Fountains, revealed a fauna containing some 20 species, no life having been previously reported from those caves.

Of plant-life, three forms of low fungoid plants occurred in Mammoth and other caves on old pieces of stick, but not in sufficient abundance to form a basis for the animal life of the caves, which was nearly all carnivorous, or, as in the case of the poduras and snails, probably thrived on the decaying fragments of wood artificially introduced into the caves. What constitutes the food of the most abundant insect of all the caverns, a wingless grasshopper, Professor Packard has not yet determined. The approximate basis of life in the caves is, without much doubt, the living and decaying animals found in them. Of *Protozoa* six forms were found in water taken from Willie's Spring, about half a mile from the mouth of Mammoth Cave. The lowest of those observed was a Vibrio, an amœba-like form, being a pear-shaped body with a number of vacuoles. Two species of *Helix* were found living and two represented by dead shells, and a *Pupa*, living, was frequent. But these mullusks may have been introduced by man, by streams, or by other agencies. The lowest worm observed was a perfectly white *Planarian*, of the usual form of the genus. No eye specks were visible. It was about ½ inch long, very active, creeping under stones in a flowing brook in Mammoth and Diamond Caves. The common earth-worm occurs in all the caves, sometimes as large as usual, but in the remoter portions of Mammoth Cave much dwarfed, not over ½ inch long. Blind craw-fish were found, but another crustacean, alleged to be found blind in an English coal mine, had well-marked eyes in the individuals taken in the Mammoth Cave. A rare scolo-

pendrella, found only once before (at Salem, Mass.), was discovered at the mouth of a small cave near the Mammoth. Several varieties of spiders were observed, and several other insects discovered and identified.

While 25 to 30 species were known to inhabit our caves, chiefly through the labors of Tellkampf, Cope, Cooke, Dr. Sloan, and others, we are now able to add 50 species to the number, which will probably be carried up to 100. (144)

CAVE-LIFE.

A PAPER was read, at the Hartford meeting of the American Association, by Professor Packard upon the cave fauna of the United States, which embraced the results of an examination upon which he has been recently engaged. These exhibit a uniformity in the distribution of cave-life throughout the entire region of the West much greater than might have been expected.

Of plant-life, three forms of low fungoid growths occurred in the Mammoth and other caves, on old pieces of stick, but not in sufficient abundance to form a basis for the animal life of the caves, which was nearly all carnivorous, except in the case of the poduras and snails, which probably thrived on the decaying fragments of wood artificially introduced into the caves.

Professor Packard was not able to determine what constituted the food of the most abundant insect of the caves—the wingless grasshopper. Of *Protozoa* six forms were found in water taken from Willie's Spring, about half a mile from the mouth of Mammoth Cave. Two species of *Helix* and one of *Pupa* were seen, although both may have been introduced by man. A Planarian worm was met with about a quarter of an inch long. The common earthworm occurs in all the caves. Blind craw-fish, spiders, beetles, etc., and fishes were among the animals observed. These researches of Dr. Packard, in addition to those previously detected, bring the number of cave species up to about one hundred.

POLARISCOPE OBJECTS.—Rev. William Law states that the following are two of the finest subjects for the polariscope which animal tissues can supply: Thin slices of the upper part of a pig's claw, cut transversely, and of the paw of the polar bear. Both are indescribably beautiful. They are, when cut, dropped into strong spirits of turpentine and mounted in Canada balsam. The bristles of the hedgehog also form very beautiful objects for the polariscope.

NEW BEDS OF FOSSILS.

Of the various government exploring expeditions that have been in the field during the past summer, the most signal success has been experienced by the party of Lieutenant Wheeler, in the discovery of certain new beds of fossil vertebrates, from which a large number of new species have been derived. The division by which this result has been achieved was under command of Dr. H. C. Yarrow, in charge of the natural history department of the survey, accompanied by Professor E. D. Cope, with several assistants. One of the newly discovered beds belongs to the eocene tertiary period, and originally constituted a fresh-water lake, probably drained off by the Chama and San Juan rivers. The shores of the lake are formed of cretaceous rocks, of an age corresponding to that of the No. 3 of Meek and Hayden. The rock in which the fossils occur is a brown and white sandstone of about a thousand feet in thickness.

A preliminary investigation given to the collections by Professor Cope shows marked differences from those of the Bridge Basin of Wyoming, some of the more characteristic genera being *Bathmodon*, *Hipposyus*, and *Phenacodus*. It is a remarkable fact in this connection that there are several species of sharks and an *Ostrea* found in connection with the mammals.

What Professor Cope considers the most striking feature of the discovery is the occurrence of two new genera, which he calls *Calamodon* and *Eitoganus*, belonging to the *Toxodontia*, an order not heretofore found in North America. Of the last-mentioned genus three species were found, and of the former one, all of them of about the size of the tapir. One reptile, a species of alligator resembling the *A. neterodon* of the Wyoming bed, was also detected.

HABITS OF THE GRASSHOPPER.

Professor Humiston, of Worthington, Minnesota, described to the *Tribune* correspondent the grasshopper's mode of depositing her eggs in the soil, a subject which he has had excellent opportunity for studying this year. The tail of the female locust consists of a hard, bony, cone-shaped substance, capable of being thrust into the ground from one-half an inch to an inch in depth. Just above this, on the body of the insect, and attached to it, is the egg cell. The grasshopper is able to push its conical tail down into the ground and leave it there, with the cell containing the eggs. The warm sun in the spring causes the eggs to hatch, and the field is covered with millions of young grasshoppers, not as large as a kernel of wheat,

just when the tender shoots of grain begin to show themselves above the ground. The damage they do is immense, for they remain a long time in one spot, and work upon the young shoots. Perhaps the best mode of treatment is "back setting," or ploughing the field, and thus turning the surface soil, with its store of eggs, several inches under. This prevents hatching, and though not a complete remedy, is very useful.

THE USES OF BEES' WINGS.

D. L. ADAIR, in an essay on the various uses of the bee's wings, holds that, besides flying, the wings of the bees serve two or three other important ends. The horny frame, upon which the fine membrane of the wings is stretched, is composed of hollow tubes of a hard substance, called *chitine*. These tubes are double, being one tube inside of another. The inner ones are extensions of the *tracheæ*, through which the air circulates in breathing; between this and the other tube is a space through which the blood circulates. The blood is brought in contact with the air through the thin walls of the air tubes, just as the air and blood are brought together in the human lungs, and with the same effect.

The nervous filaments in like manner pass to the wings; they follow the respiratory tubes and all the fine venations of the wing, terminating in every part of its surface in papillæ, which in all animals are the vehicles through which sensations are perceived. Hence we may infer that the wings are the organs of some sensation. Are these nerve filaments intended merely for noting tactile sensations? Mr. Adair is of the opinion that by means of them the bee is made conscious of odors. "Some naturalists have suggested the antennæ as the organs of smell; but, as they appear to be poorly adapted to perform such an office, it is just about as likely that they smell with them as that they see with them. Invisible particles emanating from odorous bodies, coming in contact with the olfactory nerves, produce the sense of smell. These atoms are mixed with and floating in the air, and in order to collect them, a considerable volume of air must be made to pass over their surfaces—a thing which the wings certainly accomplish in an eminent degree."

The sense of hearing in bees has never been localized by naturalists, though some have supposed that the antennæ are the organs of this sense also. "What appendage of the bee," asks Mr. Adair, "would be better suited to receive sound-vibrations than the thin, stiff membranes composing the wings?"

A CURIOUS CATERPILLAR AND ITS DESTROYER.

THE OAK CATERPILLAR AND ITS DESTROYER.

ONE of the commonest pests of the oak tree in France, is the caterpillar of the bombyx, which infests the trunks, and at certain times ascends to devour the leaves. The insect has the curious habit of descending from the foliage during rainy weather, and instead of returning to the nest, making immense annular greyish protuberances on the lower portion of the bark, which, on examination,

prove to be the living caterpillars closely huddled together.

The butterfly is of a grayish color, with a few dark bands on the anterior wings. In August and September the female deposits a set of eggs on the bark, and in May the caterpillars appear. The latter work together to make a common nest formed of layers of web, more or less regularly disposed. In this they remain quiet in daytime, and never leave except in the peculiar manner represented in the illustration. Two or three will precede in Indian file, then a few couples, and finally, the entire colony in a throng, the procession having a triangular shape, the leader at the apex.

The danger from these insects is not, however, confined to the trees, since they are disagreeable neighbors to animals of all kinds. From all portions of the body they throw off a kind of hair which is readily wafted upon the skin, into which it works, producing inflammation, or when inhaled into the lungs causes serious disorders of those organs.

It was a wise provision of nature that troublesome creatures rarely exist unaccompanied by powerful enemies, and in this instance there is no exception to the rule. The *Calosome*, a beautiful coleoptera, of a dark blue, almost violet hue, with greenish gold elytra, is a steady foe to the caterpillar, and not only attacks its processions, but sends its larvæ into the nests, to work further destruction. A larva thus engaged is shown in the illustration. When the inhabitants of the nest are destroyed, the young calosome drops to the ground, where it buries itself to a short depth. It there changes into a nymph, and finally emerges a perfect insect.

THE OYSTER WORM.

WE referred some time ago to a parasitic worm found by Professor McCrady in the genital glands of the oyster in South Carolina. It seems that a similar species has for twenty years been known to exist in Europe in the genital glands of the oyster and cardium. Its sporocysts and the *cercaria*-like young were then known, but recently M. Giard has found that these young are encysted in the *Belone vulgaris*, a fish found on the French coast. Now what finally becomes of the encysted *Bucephalus haimeanus*. Giard does not know, but supposes that it passes into another fish of the genus *Gasterostomum*, the *Belone* serving as food for this latter large fish.

THE SOLITAIRE.

In the years 1708 and 1720 Frances Leguat, a French traveler, visited the islands of Mauritius and Rodriguez, and in his account of the fauna of those little-known localities, mentioned a number of birds as living, which later investigators only encountered in the shape of fossil remnants. Among these birds was the solitaire, a mem-

THE SOLITAIRE.

ber of the pigeon family, of which, during the early part of the present century, no relics could be found, and hence Leguat's statement regarding it was currently considered as lacking in veracity.

Some fragments, however, exhumed during late years were removed to Paris, and there examined under the be-

lief that they were bones of the *Dodo*, but naturalists soon discovered that they must have belonged to a bird with feet much more elongated and having a more erect stature, corresponding, in fact, to Leguat's description of the solitaire.

Recently a large number of similar fossils have been collected, and submitted to the examination of Professors Newton, Stuckland, and Melville, who concluded that the bird was an exceptional and now extinct type of pigeon. The subject was also brought to the notice of Professor Milne-Edwards, and that eminent naturalist has constructed an entire skeleton from the fragments, as represented in the first engraving. From the skele-

THE SOLITAIRE.

ton the other characteristics of the bird have been determined, and its aspect while alive depicted, as represented in the second illustration.

The solitaire is one of a large number of birds which were ancient inhabitants of Rodriguez Island, existing thereon when the land was covered with rich vegetation, and not denuded of its forests, as is now the case. This population, the last traces of which have disappeared, was probably itself the remains of a more numerous fauna, for the volcanic nature of Rodriguez, Bourbon, and Mauritius islands, give ground for the belief that these tracts of land were the culminating points of an old continent, of which the low-lying portions became submerged at a period which it is difficult to fix.

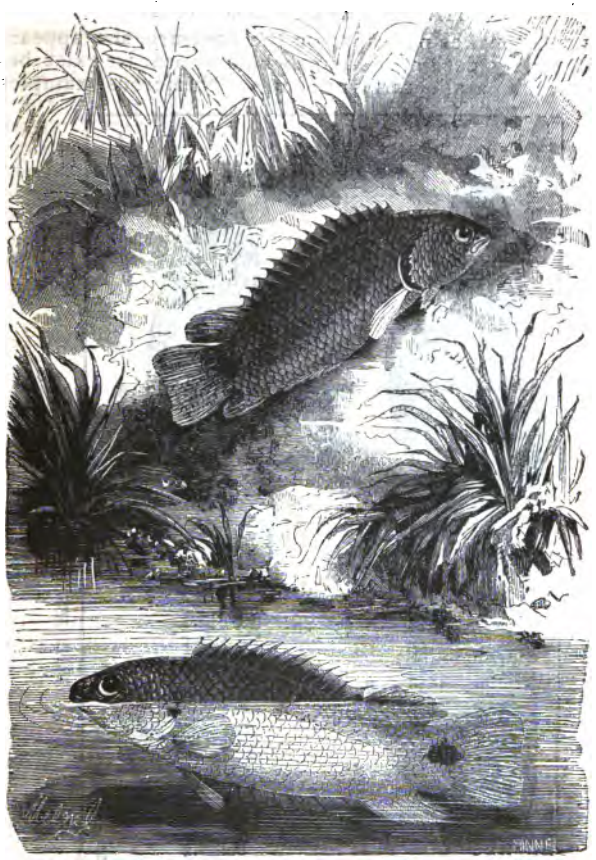
A FISH THAT CLIMBS TREES, AND DROWNS UNDER WATER.

THE *Anabas*, a remarkable fish, capable of breathing air, and of making its way over the ground, has, it is stated, been successfully acclimatized in France by M. Carbonnier, a well-known pisciculturist. The animal is a native of India and the adjacent islands, and is found in brooks and streams, which part of the year become dry. When this drought begins, the fish leaves the bed and starts across the country in search of water, remaining for weeks ashore, slowly progressing, guided by its curious instinct.

Aerial respiration is necessary to the animal, and if kept under water it will drown. It possesses gills opening into a cranial cavity near the eyes, which is traversed by numerous blood-vessels, and in which the air is maintained by respiration, being exhaled through the mouth. If the fish be held under water, this chamber fills with water, and can not clear itself. The water then becomes charged with carbonic acid, and hence is no longer able to oxygenate the blood.

The mode of progression of the anabas is especially curious. The fish resembles a thin perch in form, as shown in the engraving, with the difference, however, of a black spot at the root of the tail. As soon as it lands, it shuts its mouth and closes its scales tightly; then, by a general movement, his fins are projected—those of the breast extending like arms. The tail is flapped from side to side, the animal resting almost on its belly, and this motion, aided by that of the anal and pectoral fins, moves the body slowly over the ground.

According to Duldorff and Bloch, and also other observers, the anabas can climb trees six feet high in search of



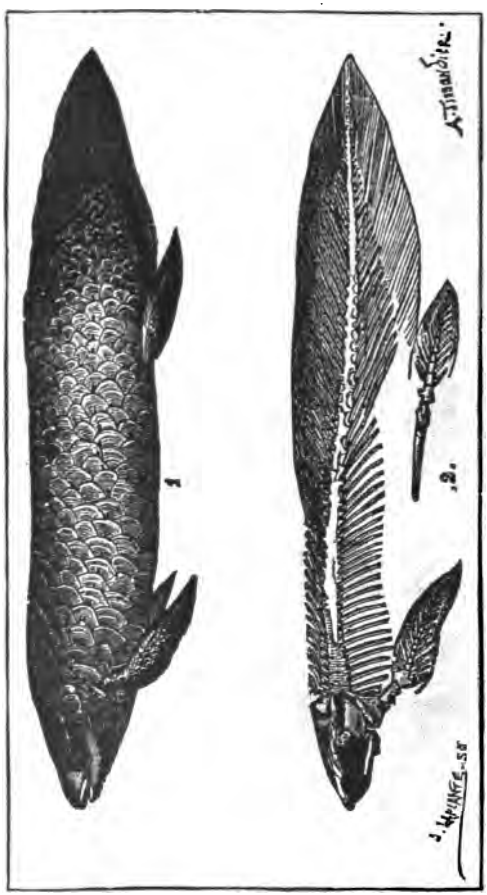
THE TREE-CLIMBING FISH.

the water gathered on the leaves; and M. Bocourt states that he has actually shot the fish while in the branches. Another odd habit the animal has is to bury itself in the mud of its pond, when the latter runs dry, sometimes doing this in preference to attempting an overland journey. A providential rain filling the basin at once brings the fish from its resting-place.

We extract our engraving from *La Nature*.

THE GRASS-EATING FISH.

NATURE makes no leaps; on the contrary, she appears to fill up, by design, the gaps which appear to exist between each parallel series of beings. Numerous examples



THE GRASS-EATING FISH.

exist, or have existed, of these odd connecting links: the Australian ornithincus, a quadruped with a bird's beak; the apteryx, a bird with hair and no wings; the pterodactyl, or winged lizard of antiquity; the fossil turtles, with

teeth, found in the Cape diamond diggings—are illustrations in point, and still another is found in the queer fish represented in our engraving. It is called the *ceratodus Forsteri*, and is allied to the fishes through the *lepidosiren*, a singular animal found in the streams and ditches near Bahia, Brazil. The *lepidosiren* is popularly termed the caracurus, and is known by its odd-shaped, elongated body, covered with scales, appearing to terminate in a fish's tail, while its means of locomotion consist in four fins located underneath. French naturalists have placed this animal in a distinct class of amphibious reptiles. Owen, on the other hand, pronounces it a fish, and the connecting link between fishes and reptiles.

The discovery of the *ceratodus*, however, adduces an even closer connection between the two families. The genus was established by Agassiz, who found the fossil teeth and jaw bones of the animal in the jurassic and triassic formations of many parts of Europe. It was supposed that, save in these ancient remains, the creature did not exist, until a few years since, when living specimens were found in the rivers of Northern Australia, exactly corresponding to the fragmentary relics.

In the annexed engraving is represented the appearance of the living fish and also of the skeleton. Its length is about 38 inches, and its diameter 7 inches. Its habits are as peculiar as its form. Although living in the rivers, it rarely ascends above the brackish water, and finds its sustenance in the vegetation which, growing in shallow places, is left uncovered by the ebb of the tide. At night the fish leaves the water, crawling in among the plants and feeding. The quantity of nourishment it needs is enormous, and it is said that the amount of half-digested myrtaceous and graminaceous foliage found in its intestines is out of all proportion to the apparent requirements of the animal. In order to pursue its habits, it is evident that air-breathing apparatus must be present in the organization, and such is the case. Its gills are a sort of porous lung, of very complicated construction, having ramifications which expand into cavities filled with a coagulum, the function of which has not been definitely determined.

THE FROG BAROMETER.—In some countries frogs are used as barometers: the species employed for this purpose is the green tree-frog. They are placed in tall glass bottles with little wooden ladders, to the top of which they always climb in fine weather, and descend at the approach of bad weather. This is a cheap and highly interesting weather glass where the green tree-frog is to be procured in its natural state.

FROG-CULTURE.

SETH GREEN, the great fish culturist and State Commissioner for stocking streams, now proposes frog culture for food. He says: "We have many stagnant pools about the country, that are useless in their present state: and believing that there is nothing made in vain, I do not know of any other use for them than to make them into frog ponds. I also believe it would make the man wealthy who could raise a million frogs and get them to market."

CURIOUS MARINE ANIMALS.

WE give herewith engravings of three odd inhabitants of the ocean bottom, brought up by the drags of the steamer "Blue Light," of the United States Fish Commission, during the investigations of last summer.

Fig. 1 represents the *Curatulus grandis*, a large worm,

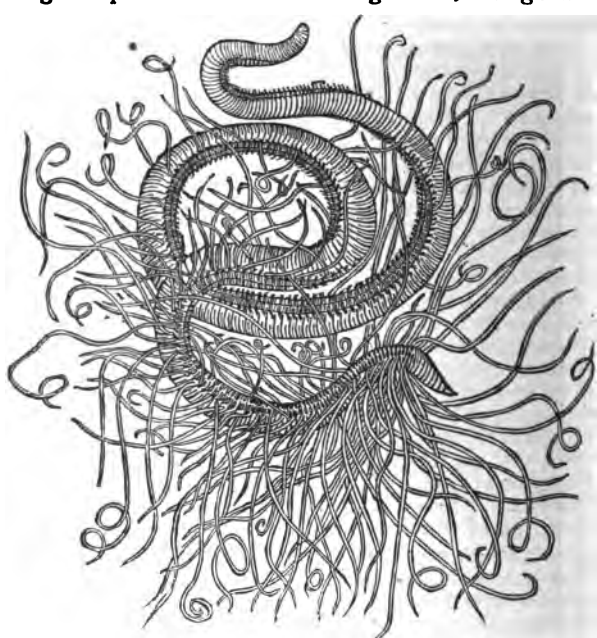


FIG. 1.

the sides of which are fringed with an immense quantity of fine filaments of a red or orange color. The crea-

ture possesses the power of contracting itself and of closely curling up its filaments, so as entirely to change its appearance. In Fig. 1, both body and filaments are

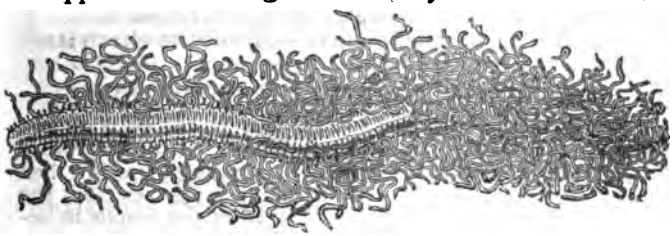


FIG. 2.

shown extended, and in Fig. 2 both are contracted. Fig. 3 is a new and beautiful sea anemone, one of those strange creations which occupy the border land between animal

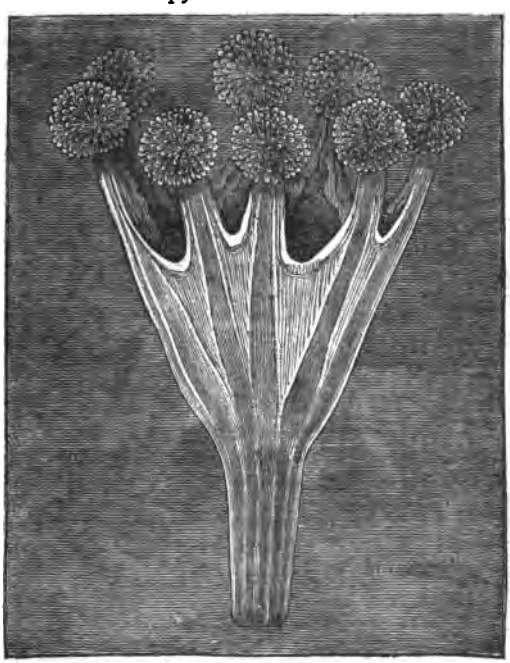


FIG. 3.

and vegetable life. The *Lucernia quadricornis* is a singular polypus, a creature somewhat higher in the scale than the anemone. It appears like a kind of sea-vegetable, but it is really an animal, though a mere gelatinous mass. It has a single sucker, by which it is enabled to attach itself to the rocks.

FISH FROM SUBTERRANEAN WATERS.

IN boring Artesian wells in the Desert of Sahara, very small fishes, resembling the white bait, not unfrequently occur, which inhabit the waters of the subterranean bed of the desert. They are identical with a species from the waters of Biskra. The male differs from the female in being transversely barred, so that some authors have regarded it as a distinct species. The eyes are well formed, although these fishes live a part of the time in obscurity. It seems that as far back as 1849 the governor of the oases of Thebes and Gaibe, in Egypt, stated that an Artesian well, about 105 feet deep, which he had cleaned out, furnished for his table fishes which probably came from the Nile, as the sand which he had brought up from this Artesian well was identical with that of this river. In the Sahara, as in Egypt, these fishes were carried away by the waters, which filtered into the soil down to the subterranean sheet into which the Artesian wells open. Gervais claims to have established the fact that these subterranean fishes are essentially fluviatile, and that some like them are found in the rivers of Senegal and Mozambique, of Syria and Egypt, of the Iberian peninsula, and even America. Their fossil representatives are not found in deposits of marine origin, and all that we know occur in lacustrine formations. The existence of these fishes can not, then, serve as an argument for the former presence of the waters of the Mediterranean on the soil of the north of Africa.

ANATOMY OF THE PORPOISE.

MR. FRANK BUCKLAND, having dissected a porpoise, gives some interesting information on the structure of that animal. In the matter of bowels it is well provided for, the specimen examined having 62 feet 2 inches of intestine. The stomach was so complicated that it could not be made out by ordinary dissection. To get round the difficulty, Mr. Bnckland hung it up by the œsophagus, and filled it with plaster-of-Paris, of which nearly a pailful was required before the organ was fully distended. It was then found that the porpoise had two stomachs—one in which the prey is kept, and the other in which it is digested. A careful section of the head showed the blow-hqle

to be a most complicated mechanism. The porpoise, being a pure mammal, has a four-cavitied heart and a pair of lungs. Now, Nature has ordained that he shall live in the sea; the problem is, how to keep water out of the lungs. In the first place, his nose is guarded by a valve placed on top of his head, and when the porpoise breathes he comes to the surface, and takes a deep inspiration. Not a drop of water ever gets in. But how does he work his valve, and keep the water out of his lungs when he is asleep? The answer to this question can not be given yet. Mr. Buckland intends to study the subject when next he has a live porpoise at the Brighton Aquarium.

GIGANTIC MOLLUSK.

AT a recent meeting of the California Academy of Sciences, a gigantic species of mollusk, belonging to the family *Pholadidæ*, named *Lirphœa crispata*, was presented by Dr. H. Behr. This singularly large specimen weighs about seven pounds, and its length is over nineteen inches, the shell itself measuring nearly ten inches. These animals burrow in mud or soft sand, protruding their long syphons above the surface of the water, expanding and contracting them at will. They form a favorite article of food of the seals and walruses, as well as of many kinds of birds. The present specimen was obtained in British Columbia.

ALLIGATORS SWALLOWING THEIR YOUNG.—Colonel Caleb G. Forshey, of the New Orleans Academy of Science, *apropos* of the question whether snakes swallow their young, states that this habit is certainly found among alligators. "That alligators swallow their young," says Prof. Forshey, "I have had ocular demonstration in a single case; and have the universal tradition of negroes and whites in this region of Louisiana, Mississippi, and Texas, that such is their habit. In the winter of 1843–44, I was engaged making a survey on the banks of the Homochitto Lake. The day was warm and sunny, and, as I halted near the margin of a pond partly dried up, to pick up some shells, I started a litter of young alligators, that scampered off, yelping like puppies, and retreating some twenty yards to the bank of Lake Homochitto. I saw them reach their refuge in the mouth of a five-foot alligator. She evidently held open her mouth to receive them, as, in single file, they passed in beyond my observation. The dam then turned slowly round, and slid down beneath the water, passing into a large opening in the bank, beneath the root of an ash-tree. Doubtless this refuge is temporary, and the young are released at their own or the mother's pleasure."

AMERICAN OYSTER-CULTURE.

THE following recent information on this subject is by Mr. James Richardson:

Ever since the country was first settled, Long Island Sound has been noted for producing oysters of superior size and quality. They are of the northern species, characterized by great breadth and thickness, firm white meats, and delicate flavor, qualities which the southern oyster can not rival even when transplanted into the same waters. Owing to the streams which freshen the water along the Connecticut shore from Greenwich to Bridgeport, and to a less degree farther east, where the influence of the open sea is more strongly felt, the oysters along this coast attain a quicker and finer development than elsewhere, the culminating points being in the swift channels among the rocky islands off Norwalk—the home of the original "Saddle-rocks," the "Sounds," and other standard varieties: all the same oyster, though differing in size, shape, color, and flavor, with the position and character of their bed and the accidents of their development.

Twenty years ago, in the oyster business of this region, artificial propagation was unknown, and when the native grounds were exhausted, the supply was kept up by restocking them with "seed," or small oysters brought from the Chesapeake Bay or the Hudson River. Among the oystermen of Norwalk at that time were the Hoyt Brothers, young men who had brought to the business more than the usual allowance of brains. Not satisfied with merely handling oysters, they sought to understand them, studying them in the water and out of it with a persevering directness that would have delighted the heart of Agassiz. Observing that native spat would sometimes settle upon seed brought from abroad, they set to work to discover the conditions of such fixing of spawn, rightly arguing that, the secret once penetrated, they might save themselves the trouble and cost of going elsewhere for seed, besides securing a better breed of oysters.

Had they known anything of European experiments in oyster-culture, they might have got on faster at first: they might also have been led astray and discouraged, as others have been, by fruitless imitations of foreign methods. The climatic and other conditions here are so unlike those of France or Italy that entirely different methods of oyster-culture are required. On the whole, therefore, it was fortunate that the Hoyts had to begin at the bottom and learn everything by personal observation and experiment. It was fortunate, too, that with Yankee common sense they pitched upon the master key to the

problem at first, and sought to discover the natural conditions of oyster propagation on their own grounds. One year the Sound's bed will be literally covered with oyster spat; the next, it may be, though the oysters spawn as abundantly, scarcely a young oyster will be found. Again, there will be a year like 1873, when there will be no spawn. Their problem, it will be seen, was no easy one to solve.

After much study of oysters and oyster grounds, and many trials with different materials for fixing the spawn, our experimenters learned at last that the securing of a crop of seed depends upon two essential conditions: first, that the parent oysters spawn; second, that, at the time of spawning, the floating spat must have presented to them something clean to which to attach themselves; it may be stone, shell, glass, iron, wood, leather, anything, in short, provided it is perfectly clean. The first great point in artificial oyster propagation is therefore to know just when to have the stools on the ground. The time of spawning varies with the season, the position of the bed, and the depth of water over it, so that it requires close watching, with frequent dissections, to determine the precise moment when the spawn begins to run. If the stool is presented too late, the spawn is lost and the stool worse than wasted; if too soon, it is equally thrown away, since it becomes covered with white slime in a few days, and then the spat can not strike. Sometimes a heavy storm at spawning time comes to the aid of the oyster farmer, and adds immensely to the productiveness of natural beds: it churns up the gravel and shells on the bottom, scours them clean, beats the slime off the rocks, and brightens things generally for the reception of the coming spat. Last summer the spawn was abundant; the natural conditions for its lodgment were unusually favorable; and if the starfish and other enemies of the oyster do not destroy the crop, it will be an unusually productive one. But we are getting ahead of our history.

Having come to the conclusion that clean stools at spawning time were the one thing needed to fix the native spawn, the Hoyt brothers gathered up some thousands of bushels of weather-worn shells and scattered them over their grounds. Naturally they were laughed at by "practical" oystermen, who had been in the business for years and knew "all about it"; while other men threatened them with all sorts of penalties for filling up the channels, and otherwise interfering with the natural order of things. Their venture, however, proved eminently successful; the clean shells were quickly covered with spat, and sixteen years ago they reaped their first crop of arti-

ficially propagated oysters. There is nothing that commands respect like success. Seeing the result, those who had scoffed at the method were eager enough to try it. A new impetus was given to the oyster business. Exhausted oyster grounds were restocked, and miles of hitherto unproductive grounds were brought under cultivation. From Greenwich to Westport there is not a break in the oyster beds, the great bulk of them owing their existence to artificial propagation.

The stools chiefly prized are shells and screened gravel, ranging in size from a hickory nut to a hen's egg. The fragile amber-colored shells which abound throughout the Sound—the oystermen call them "gingles"—make excellent stools: so do scollop shells, boat loads of which are brought from the Rhode Island shore for this purpose. Large stools are less desirable, since the oysters crowd and pinch each other on them, and the bunches are harder to separate when the time for transplanting arrives. Still, in many cases it is necessary to scatter comparatively large shells and stone, among the finer shoals, their action being apparently to create little rests or eddies in the water flowing over the bottom, thus enabling the spawn to strike.

In the costly tile and cone devices for taking spat, employed by the French systems, the fixing of a few hundred thousand spat is accounted something wonderful, and, much to the amusement of our oyster-growers, American newspapers have copied French reports, wonderment and all, when within an hour's ride of their publication offices are breeding-grounds of many acres, sown with spat in countless millions. Our oystermen number such small things only by the bushel. Over large areas, this year's seed is so plentiful that an ordinary "drag," holding a bushel or more, will be filled by drawing it loosely over a strip of bottom a yard wide and a rod long. A bit of shell as big as one's finger nail will carry perhaps half a dozen spat, and as many as sixty or eighty may be counted on a single valve of an oyster shell.

The diminutive breeding-grounds which the French make so much of—creeks and puddles, we have heard them called by men accustomed to the larger spaces under cultivation here—compare with those of Long Island about as a kitchen garden with a Californian wheat farm. The difficulty along the Connecticut shore is not in propagating the oyster—that is easy enough now—but in maintaining the crop until it is mature. It is only by the most persistent warfare against starfish and other oyster enemies that uniform success is possible.

Let us visit the oyster-farmer at home, and study the methods of his business, their object, and the effect they have on the development of our much-prized and most delicious product of Neptune's kingdom.

First, to the breeding-ground.

To the casual visitor, sailing over an oyster plantation, it is the blankest of all cultivated areas. He sees but a waste of water, with here and there a protruding pole, and is but vaguely impressed when assured that as far as his eye can reach the ground is covered with crops in various stages of maturity. Strange farming, under twenty feet of brine! In the middle of a broad bay, perhaps a mile from shore, our tidy craft is put about, and our skipper says we are over a "patch" of twenty acres devoted to this year's spawn. For miles around the Sound is staked off for oyster-beds, and hundreds, perhaps thousands, of acres, belonging to other oyster-farmers, are in use as breeding-grounds. As we drift across our twenty-acre field, a dredge is thrown over, and a moment after the quivering rope tells that the dredge is at work on the bottom. We drift a boat's length, and the catch is hauled in—a bushel or so of empty shells, half a dozen crabs, any quantity of amber-colored "gingles," and perhaps two or three oysters.

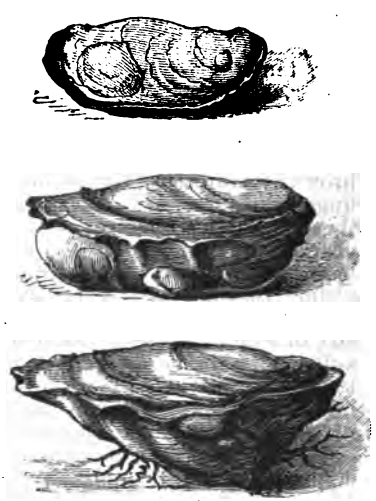
"Nothing here!" you are tempted to say; bnt look closer. Every one of those empty shells, every object that has not escaped through the meshes of the net, is covered with rough brown creatures, the size of one's finger-nail. They are oyster spat, that is, young oysters of this year's spawning, now three months old. They first become visible to the naked eye when about a week old. A gingle the size of a nickel coin carries half-a-dozen; a nodule of coral as large as a walnut bears twenty; on half an oyster shell you count fifty or sixty, perhaps a hundred or more, if you have patience to distinguish the little ones. Who can number the thousand on a square yard, the millions on an acre, every inch of which is sown with promises of future stews and fries?

OYSTER SPAT.

As we pass to other grounds, the dredge is cast on the gravelly shell-strewn bottom of a swift channel, in a quiet

cove, in deep water and in shallow; each time the dredge is filled with rubbish interspersed with old oysters, clams, scallops, and other denizens of salt water. Here and there a bright shell, a pebble, or a bit of coal will show an oyster spat; but a whole dredge full of stuff will carry fewer than a single oyster shell from the breeding-ground. It is the old story of Nature *versus* cultivation.

At spawning time last summer, the waters over the several areas were equally filled with microscopic oysters, millions of which were sent adrift by each prolific parent. They swarm, free and independent, like other young people, for awhile; but the time soon came when they had to settle for life. At this critical stage of their existence, those on the breeding-ground were plentifully provided with enticing resting-places, in the shape of clean shells, gravel, and the like, and they settled in myriads. Those which had Nature for nurse had to take their chances, and on the uncultivated grounds the chances were relatively few, notwithstanding the season was an uncommonly favorable one for natural beds. The furnishing of clean stools for the young spat is thus a matter of prime importance in oyster-culture, and it is of equal importance that the stools are provided at the right time. The period of spawning varies with the position of the bed, the depth of the water, and other conditions, from June to August. The precise time for each bed must be discovered "with the knife," that is to say, by dissecting the oysters. By this, which is purely an American method of breeding, it matters little how deep the water may be; shells and gravel will sink as readily through a hundred feet as certainly as through ten. The shallow breeding-places employed by the French would not answer at all in our climate, no more



SEED OYSTERS—1, 2, AND 3 YEARS OLD.

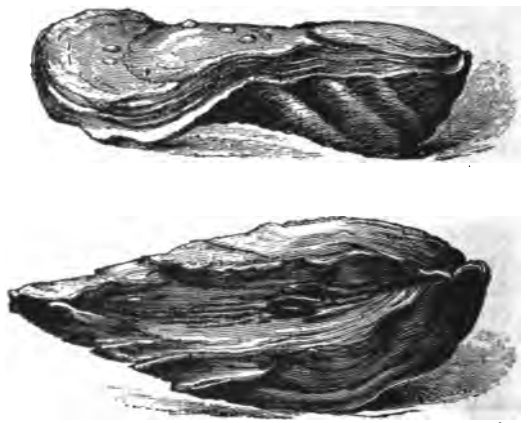
would their costly and clumsy contrivances for fixing the spawn. There the securing of a few hundred thousand spat is accounted a great achievement. Here it is the least of the oyster-breeder's labors to obtain boat-loads of them. The trouble is to defend them during the five years of their development.

Examine one of the spat-ladened stools. It is obvious that such a crowd of oysters can not come to any size in so small a space. If left to themselves, few could survive the struggle for existence, and they would be pinched and meagre. The oyster-farmer does not permit such a waste of seed. Yonder sloop, which has been beating back and forth across our breeding-ground, is nearly laden with a worthless-looking cargo—in reality, a wealth of seed that would be a small fortune to a foreign breeder. The business of her crew is, primarily, to keep watch against invasion by starfish and other foes of the young oysters. Their coarse-meshed dredges bring up quantities of spat-covered shells which are kept for distribution on other grounds, quite as many spat as can thrive on the ground being attached to stools small enough to slip through the dredges. Next summer the year-old seed will be similarly thinned, the clusters broken up, and the surplus transplanted. The same process will be repeated the year after; the next year the entire crop will be lifted; it happening that the oysters thrive exceedingly well on this particular ground up to their third year, after which their growth is too slow for profit. Transplanted to more favorable ground, they increase in size and thickness very rapidly.

PINCHED.

By thus choosing grounds specially suited to the several stages of the oyster's development, the breeder is able to hasten the maturity of his crop, besides securing a higher average of size and quality in the product. On a firm, gravelly bottom, for example, where a free circulation of water is maintained under and around the oysters, a crop will accomplish as much in four years as in five on mud, and the quality will be much superior.

It is now on what may be called the fattening-ground,



THE EFFECT OF TRANSPLANTING.

the firm, gravelly bottom of a channel between rocky islands, swept by a tide which runs like a river in flood. Here the oysters spend their last season, with as much enjoyment, we fancy, as oysters are capable of. The conditions of oyster-life are here evidently at their best, for the oysters improve astonishingly, doubling in bulk of meat, it may be, in six months. Here the crooked are made straight by their own efforts, the slender grow broad and round, the lank become stout, and the flesh of all grows plump and hard to the very gills.

But the oyster is not yet in condition to tickle the palate of the epicure. It is full of bitter, salt sea-water; the gills are discolored, and the whole system needs renovating. It must have a drink of fresh water. The common run of oysters are taken direct from the "salt" to the market. Not so the fancy product of cultivation. These are taken to the mouth of a sweet-watered river and placed for a few hours in a shallow float, which swims near the surface of the water. Here the oysters "drink," as it is technically called, spirting vigorously, and freeing themselves of all deteriorating matter. Open one now. It lies plump and white in the shell, rounded to the gills, which are scarcely visible, in every part clean and tempting to the most fastidious. Taste it, and know how sweetly delicate an oyster may be!

Not many people know it, but there is as great a differ-

ence between a thoroughbred oyster, properly handled, and an ordinary oyster such as one sees in the markets, as there is between a rough seedling pear and a bartlett which melts in the mouth. Those who have learned the difference experimentally will eat no other where the cultivated are to be found.

The variety we have been studying are genuine "saddle-rocks," raised on their native soil. Other varieties differ in color and flavor, and have their local admirers; but none surpass the true saddle-rock in all the qualities that form the perfect oyster.

THE ENEMIES OF THE OYSTER.

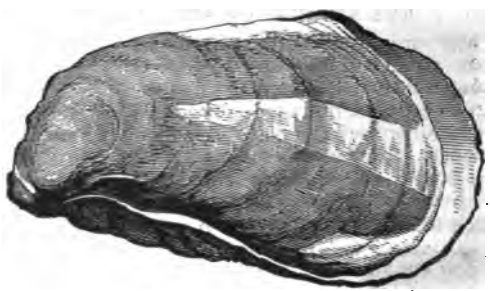
The chief animate enemies of the oyster and the oyster-cultivator are the starfish, the drill, and—shall we say it?—the periwinkle. The starfish is perennial. It is to the oyster-grower what the grasshopper or the army worm is to the farmer on *terra firma*. Its worst assaults, too, are made in like manner, that is, in overwhelming masses. The sea is full of them, and at times they will come up from deep water in solid column, broad enough to run over large areas, and so numerous that not a living thing remains in their path. Miles of oyster beds have been laid waste by them, and the perpetual possibility of such invasions makes the oyster-grower's investment extremely precarious. It is only by constant dredging that it is possible to do anything on the north shore of the Sound, the cost of carrying on the war, with the losses entailed, making the heaviest of the oyster-breeder's taxes. On the Long Island shore they have been, we are told, less troublesome of late. By persistent labor, many grounds formerly given over to their ravages have been recovered; and when steam comes to be more generally useful in dredging, it is possible that the pest may be quite overcome and exterminated.

STARFISH AT WORK.

A short time ago one of our scientific contemporaries published a digest of a French report, in which the starfish was described as helping to complete the work of destruction begun by the drill. It

would be fortunate, indeed, for our oyster-breeders if the stars were thus dependent. It is true enough that the drill paralyzes the oyster (chiefly those under three years old) by boring a hole into the oyster's heart, as its large muscle is called; but the star waits for no such intervention. On the contrary, it destroys both the drill and the oyster, and every other mollusk it comes across.

The rapidity with which stars destroys oysters, and the invariable corrosion of the outer edge of one of the valves of the oyster's shell, making it shorter than the other and the junction of the two imperfect, is evidence enough that



WORK OF STARFISH.

the burglar waits for no opening of the door. By what process the shell is eaten away, whether by an acid secretion or otherwise, we do not know. That it is eaten away, the shell of every oyster killed by stars bears unmistakable testimony.

The case of the periwinkle is less clear. The assertion of certain naturalists that the 'winkle is a harmless and innocent vegetarian is met with such derision, by oystermen, as shepherds would be likely to greet the assertion with that wolves eat nothing but grass. They regard 'winkle as the chief destroyer of mature oysters, and will show you just how the oyster's nose is broken off between the tough foot of the 'winkle and its outer shell. They have caught the rascal in the act time and again, with more or less of the oyster devoured. It is a pretty case of conflicting testimony as it stands, possibly one of mistaken identity.

The drum-fish, which makes such havoc among oysters of other localities, is but an occasional visitor in the Sound, and never in sufficient force to do much harm.

It must not be supposed that this exhausts the list of the difficulties and dangers which the oyster-grower has

to contend against. Inanimate as well as animate Nature bears hard upon him in more ways than we have space for mentioning. Nevertheless endurance, pluck, and energy prevail in this as in other forms of industry, especially new ones, in which everything has to be learned by experience. Though greatly extended during late years, the business of oyster-culture is yet in its infancy. It can not fail to become more and more important as rapid transit broadens the area over which live oysters may be distributed, and more of the inhabitants of the interior learn to know the oyster's capabilities. (83)

THE PHYSIOLOGY OF THE OYSTER.

By persons engaged in the business, we have been asked, says the Rev. Samuel Lockwood, "Are there hes and shes among the oysters?" The answer to the naturalist would be, "There are not." Low down in the scale of life, many animals on their sexual side are singularly suggestive of plants. Take, for example, that splendid grass, *Zea mays*—Indian corn. On the top of this graceful plant is a large, brush-like panicle. This contains the staminate or male flowers. Embedded in the green cob of the ear are the pistillate or female flowers. Their pistils make the tassel, which is called "the silk." Upon these falls the fertilizing pollen of the stamens from the raceme above. Without this contact there would be no kernels on the cob. In some plants this bisexuality occurs in the same flower. A notable instance is that of the prolific strawberry known as Wilson's Albany Seedling. A similar fact, certainly an analogous one, is true of the oyster. It is bisexual. It is not masculine alone, nor feminine alone, but both; and perhaps might be defined by that innovation in modern grammar, as of "the common gender." It is hermaphroditic.

If we take an oyster in the hand, it will be observed that, of the two valves or shells, one is much deeper and heavier than the other. This is the bottom or lower valve, because, when lying undisturbed on the bed of the water, it is the under side. The upper valve is often a mere thin plate of shell. The valve, then, represented by the cut, is the lower or deep valve.

We find a thin sheet of flesh lying on the shell. It is the left mantle, for there are two, one to cover the right side also, so that both together are continuous as one, and with it the animal inwraps itself.

The figure shows a porion of the right or upper lobe of the mantle. It is sometimes called the pallium, and really is the oyster's cloak, though it is always and only worn in

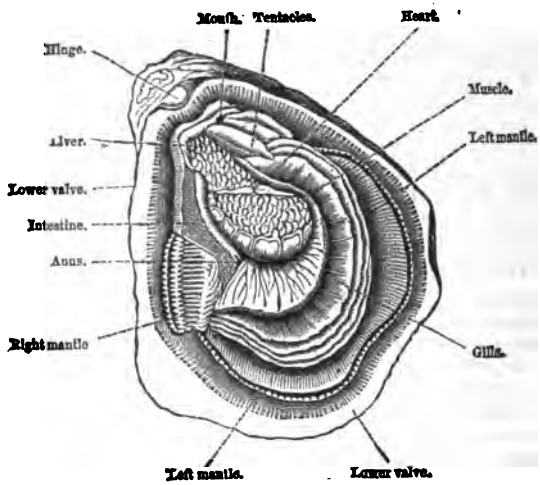


FIG. 1.—ORGANISM OF AN OYSTER.

the house. The animal extends both folds of the mantle outside of itself and over the shell, and that line is where the lips of the folds meet. This mantle has much to do with obtaining food. The oyster opens its shell about a quarter of an inch apart. These membranes, that make the mantles from both sides of the animal, meet just at the opening of the shell. They are fringed at their edges with rows of tiny cilia, or soft flesh hairs, of extreme delicacy. This pallial fringe in an eminent degree serves the oyster as organs of touch. Probably this sense, though distributed somewhat over the entire surface of the body, is along this fringe exquisitely acute. The English call this fringe the oyster's beard. It is protruded just a little out of the shell; and these cilia, almost numberless, keeping up their rapid movements in the water, make as it were two parallel vibrating curves, which beget a sort of aquatic vacuum inside the shell, into which the water flows, as in a diminutive whirlpool. The stream thus affected brings with it the algæ spores and animalcules which constitute the oyster's food. But where is the oyster's mouth? Speaking popularly, it is away back near the hinge of the shell, as shown in the cut. To this point the current flows. The stomach is not shown in the cut, being overlaid by the other organs. The intestine, at least a part of it, is exposed, and its extremity is really the anus

or vent. So much, then, is apparent, that the oyster possesses an alimentary system of some complexity.

A series of plaits or plaited frills, lies on the mantle, if indeed it is not a specialized portion of that organ. These plaits are the branchiæ or gills. In the respiratoy system of an oyster these branchiæ or gills are precisely the same to it as the gills are to a fish, or our lungs to us. Through these gills the water is passed. After imparting to the blood the oxygen taken from the air which the water contained, that water, now ladened with carbonic-acid gas, is expelled at the respiratory aperture, or ex-current orifice, the dark spot in the figure immediately under the end of the intestine, which we have already said is the anus or vent, whence this refuse-water, like a cleansing stream, passes directly out of the shell. This contrivance is certainly very beautiful. It is, in fact, a miniature sewer, carrying off promptly and quickly the excrements as fast as they are made.

The heart, constricted at the middle like the former silk purses of the ladies, is shown in place. The constriction separates the auricle and the ventricle. And so even an oyster has three sets of circulating organs, the heart with its double set of functions, and the arteries and veins. And this little organ beats with regular pulsations. That little auricle receives the blood from the gills, and that tiny ventricle is the vital force-pump that propels it into the arteries. "From the capillary extremities of the arteries it collects again into the veins, circulates a second time through the respiratory organs, and returns to the heart as arterial blood." The color of the oyster's blood is a pale, bluish white—in fact, it may be called opaline. Our oyster, then, is not a heartless thing. If you open it with care and skill, as would the naturalist, you may see and count the throbbings of its tiny heart.

In its proper place is seen the liver, which is always a large organ in the mollusca, or so-called shell-fish. It is true that this organ in the oyster secretes bile, and doubtless in large quantities. It is not probable, however, that this organ, though large, ever performs a metaphorical function, for it is very doubtful whether the oyster ever gets up the amount of emotion necessary "to stir one's bile." To the fast liver this oyster-liver is everything. The secret is just here: this secretion of the liver is the real appetizer of the feast. This oyster-bile is both gustatory and digestive. It excites the glands of the palate and the secretions of the stomach. The part indicated by the word muscle is the portion through which the knife is passed when opening an oyster. In popular par-

lance it is sometimes called the "eye," and by some the "heart;" terms which, thus applied, are without meaning. It is the adductor muscle, and is the organ with which the oyster pulls to its doors.

When the animal desires to shut up the valves, it contracts the great adductor muscle. When it needs to open them, it relaxes that muscle, and the valves open of themselves.

The growth of an oyster shell is always at the edge. It is effected by the rim of the mantle, as a series of delicate tips assorting the lime which is held in solution in the sea-water, and most daintily laying in its proper place the invisible cement.

Let us look closely at Fig. 2, which represents the nervous system of an oyster. It is necessary, in the study of the nerves of the invertebrate animals, to use the word *ganglion*, which means a knot of nerves. Really, it signifies a little brain, so that an insect or a mollusk may have several brains in different parts of its body. At *b*, then, we see the large brain of the oyster called the posterior ganglion. There are two curved branches, marked *c c*, which connect this brain with two comb-like objects. These are the nerves of the branchiæ or gills. This brain, then, has direct control of the mechanism and functions of respiration. But it is noticeable that it is also connected with the entire system of the two nerve-lines, *d d*, which suggest the spinal cord of the vertebrates. And this double nerve-line crosses the two ganglia or little brains, *a a*, which are connected by the transverse nerve-branch, *e*; thus the mouth, whose place is shown by the half-moon, is encircled by a nerve-ring, and this regulates the functions of ingestion. It is plain that, with a brain outfit of such a character and quantity, there must be something

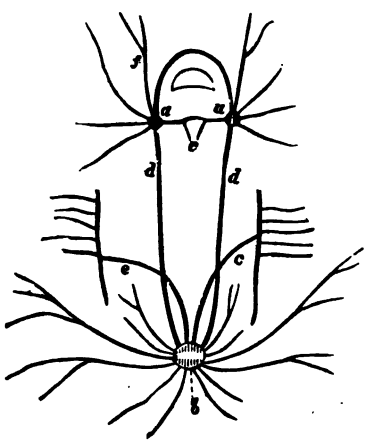


FIG. 2.—THE NERVOUS SYSTEM OF THE OYSTER.

of a corresponding brain-force. As to what sort of impressions an oyster can receive, and what kind of thinking it can do, it is affirmed that a bed of oysters has been seen to close by a precautionary impulse at the approach of a row-boat, even before the shadow of the approaching boat had reached them. Now, this is more than a blind man's distinguishing light from darkness. Is not that an exquisite sensitiveness which can thus note the faintest tint of shadow—the extremest margin of an oncoming obscuraton. (77)

THE LOBSTER.

IN a recent paper Prof. W. W. Wheildon referred to the first mention of lobsters in the accounts of the Plymouth Colony, as early as September 18, 1621, and of their mention in the early histories of Wood, Higginson, and others. The fishery at the present time has grown up from 200,000 for the Northern markets in 1858 to the number of many millions in 1874, besides the vast amount canned and shipped to foreign countries. He thinks that there is no regular spawning process, and that spawn can be obtained in every month in the year. During the year 1874 spawn was very abundant in January and February, in various stages of development. It has heretofore been contended that lobsters spawned annually in the summer months; but this belief among the fishermen has been gradually given up. It is pretty certain that on account of the consumption of young lobsters by numerous kinds of fish, only a small percentage of the spawn reach a marketable size. He said that there was no certainty that lobsters spawn annually, or that some of them may not spawn more frequently.

The young, it is known, live upon very minute animals, and the full-grown lobsters feed on muscles, clams, and other shell-fish. The young have been known to eat each other, and it is possible that something of this habit continues in the adult lobster. The very young lobster seems to be a fish without a shell and having fins and a tail like common fish, and swims altogether at or near the surface of the water. They grow very rapidly, and undoubtedly attain the form and character of the lobster in the first season.

Formerly the market lobsters averaged four pounds; at the present time hardly more than two pounds. Lobsters are believed to have been taken of 25 and 30 pounds weight, and there is a legend of one which weighed 42 pounds, so that the size to which they may grow is altogether uncertain.

One of the most interesting peculiarities of the lobster is that of shedding its shell, in common with other crustacea. The statement is made, and generally believed, that the lobster sheds its shell after reaching a certain age, annually, and some fishermen go so far as to determine the months of the year when this change of shell occurs. There are insurmountable objections to this statement; but as the soft-shelled lobsters have been so generally thrown back into the water, observation has been somewhat limited. Professor Wheildon inclines to believe that lobsters which have recently shed their shells are to be found not in the spring or summer months alone, but at all seasons of the year. At the time of shedding the shell the animals are much reduced in flesh, but less so than is generally supposed. The new shell of the lobster is at first a mere skin, which has been formed under the shell, and resembles very thin india-rubber cloth; like the shell, it becomes red when boiled. Lobsters, it has been said, sometimes make their escape by slipping out of their shell, but this is simply an exaggeration. They have the power of throwing off a claw in case of necessity, but this is never done at the joint, but by breaking the shell at a particular point in the small part of the claw. Some recent measurements show the growth of the lobster. In one case the lobster was one inch and a half longer than the shell just left, and the measurement around the body was three-fourths of an inch longer than the shell. The change of the shell is undoubtedly a necessity of growth dependent upon that, and of course can hardly be considered as an annual or even periodic change without qualification.

The process of shedding the shell is generally known, excepting perhaps that relating to the large claws. The body opens in a straight line in the length of the back, while the tail, legs, and claws are drawn out from the shell, leaving it entire, or, as it has been called, an "articulated skeleton," which is thrown off periodically. "In casting their shells," says Rees, "it is hard to conceive how the lobsters are able to draw the flesh of their large claws out, leaving the shell entire and attached to their body, in which state they are constantly found. The fishermen say that the lobsters pine before casting, till the flesh of the large claws is no thicker than the quill of a goose, which enables it to draw its parts through the joints and narrow passage near the brink." This has long been a puzzle to fishermen and naturalists. Another difficulty in the case is the presence of a cartilage in the flesh of the large claw, which does not shrink, as stated.

Upon a careful examination of this subject, with the assistance of Mr. S. M. Johnson, of Boston, Professor Wheildon undertakes to explain this apparent difficulty. It is found that in that portion of the claw near the body a part of the shell decays and falls out, making sufficient room for the passage of the claw. The portion of the shell indicated is that small smooth part that lies flat upon the body. The lines indicating this portion are to be distinctly seen in all lobsters which are approaching the period of shedding the shell, and these become gradually more distinct until the part beomes semi-transparent and finally decays. In lobsters of the size of those brought to market the portion of claw referred to may be covered with the thumb. (144)

AN ALCOHOL AND VINEGAR POLYPUS.

THE Jardin d'Acclimatation of Paris was recently presented with a medusan polypus, which, on its reception, was placed in a tank of water with similar organisms. To the surprise of the curators of the aquaria, it was found that after the lapse of twenty-four hours the creature had killed every other occupant of the vessel, and remained alone in the midst of a quite large empty space. After some speculation over the apparent mystery, the analysis of the water was made, proving that the liquid was water no longer, but vinegar. The polypus, it appeared, was one of a very rare species of mollusk, which, when placed in pure water, has the property of changing the same into a strongly characterized acetic solution. The animal, it is said, produces alcohol, which it transforms into vinegar.

PHYSICAL FORCES.

M. MENIER, in a clever book, called *l'Impot sur le Capitol*, says: "Homer shows us twelve slave women preparing meal with stone mills for the daily consumption of the heroes." Now a woman working hard all day can not make meal for more than twenty-five persons. Of course, then, in the heroic ages, there must have been absorbed an enormous amount of capital paid out for labor. To-day twenty millers in an ordinary establishment can produce, by means of machinery, flour enough for the daily consumption of 72,000 people, or each man can feed 3,600 men. In Homer's time it would have taken 144 millers. If all the machine-made cotton thread produced in England was turned out by hand, it would represent the individual labor of ninety-one millions of people. A smart woman can make eighty stitches a minute with her knitting-needles, while a machine is working 480,000 stitches. The machine, then, represents 6,000 workwomen.

SMALL BRAINS IN THE EARLY ANIMALS.

By Prof. O. C. Marsh.—It is only from the lower part of the eocene period to the present time that any comparison can be made of the size of the brain in mammals. The fortunate discovery of the great eocene basin of the Rocky Mountains, has given us a great number of eocene mammals. Now, in comparing the animals from that region with those of the miocene and the pliocene, which are still above the eocene, Prof. Marsh has found a wonderful variation in the size of the brain, which is as unexpected as it is startling, and really may be a new development in the natural history of mammals. The first animal to which Prof. Marsh calls attention is the Dinoceras, an animal about the size of the elephant, but differing widely from any known elephant, or anything of that character, in having three pairs of horns, one pair being on the nose. The bulk of the animal was nearly equal to that of the elephant. A singular peculiarity of this animal is that, though large as an elephant, it has a remarkably small brain, a brain hardly larger, in fact, than that of the average dog. The rhinoceros is not more than one-fifth of the bulk of the Dinoceras, and yet the brain-case is eight times larger than that of the Dinoceras of the eocene.

Now, if we come to the next formation above that—the miocene—we have another animal of equal size—the Brontotherium, which is as large as an elephant, with a skull just a yard in length. It has only one pair of horns, while the Dinoceras has three. It has also immense molar teeth and very minute canine teeth, while the Dinoceras has the reverse. In comparing the size of the brain of the two mammals, which are each the giants of their formation, we find in this last one—of the miocene—that the brain is much larger. It is about as large as that of a rhinoceros. The difference between the brains of the two mammals is startling.

In the pliocene, which is above the miocene, we have the Mastodon, extinct specimens of which have been found so abundantly in the United States, which is about the same size as the Brontotherium, but we see the brain is much larger, and that it increases with each formation. The brain case of the pliocene Mastodon would be more than double the size of the Brontotherium. Now take the largest mammal existing; we find the bulk remaining the same, but the brain vastly larger. Prof. Marsh has not had an opportunity to make careful comparisons, but so far as he has made them he has found the brain smaller than

in the living elephant. If this proves true, we have a remarkable series of developments of the brain. The brain of the Dinoceras is smaller in proportion than the brain of reptiles.

To carry this comparison through other forms is more difficult, especially in the minute animals. So far as Prof. Marsh has compared them, however, he finds that the same law holds good. It is an important subject, as bearing on the evolution of mammals. (144)

POTTERY OF THE MOUND-BUILDERS.

By Prof. E. T. Cox.—The so-called pottery of the mound-builders resembles in many respects that made by the Aztecs or Toltecs of South America and Mexico, and furnishes another link in the chain of evidence which serves to trace these remarkable people to a common origin.

The pottery from the mounds of Indiana is represented by a great variety of vessels, fashioned after quaint designs and adapted to multitudinous uses. Jugs with long necks, and necks terminated by figures made to represent the heads of men, quadrupeds, and birds: pots with ears and shaped like the ordinary cast-iron dinner-pot of to-day; drinking-cups; basins of great size, used for making salt by solar evaporation; smoking pipes, etc.

A great many whole vessels and fragments of this ware from all parts of the Western States have been examined by Prof. Cox, and he has been unable to find any evidence of its having been hardened by fire, nor does he believe that it was sun-baked. It is composed of a mixture of river-mud, and, most generally, pulverized fresh-water shells, united in such proportions as to make a cement that hardens in the air, or when exposed to moisture, like the concrete of the ancient Romans, and may, consequently, be classed as artificial stone. In chemical composition it agrees very closely with the concrete made of ordinary cement stones.

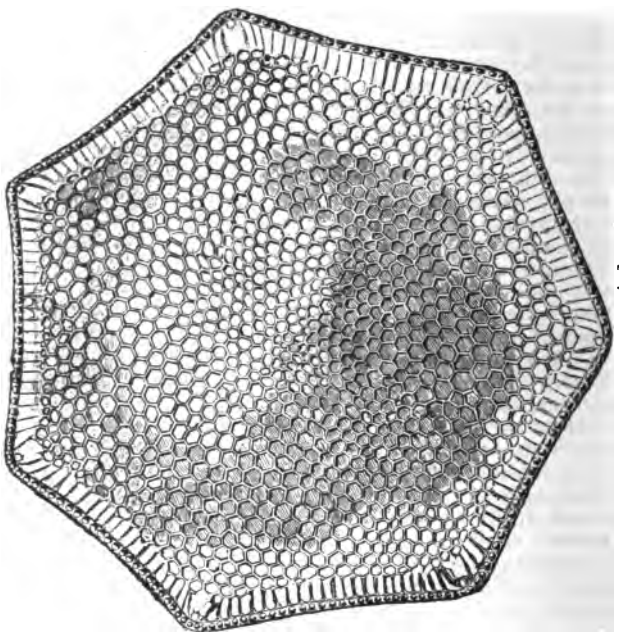
These facts lead to the conclusion that the art of manufacturing concrete or artificial stone did not originate solely with the ancient Romans, but that it was alike understood by the earliest aborigines of America.

Though it is his opinion that the so-called pottery of the mound-builders was fashioned by hand without the use of a lathe, yet he is convinced that the ancient pottery of Peru and other South American States was largely made of pieces formed by pressing the cement into molds, and these pieces were subsequently united together to form the entire vessel. The lines of union are usually

covered by a band or some grotesque image. The numerous tubercles and other raised ornaments which cover the surfaces of jugs, vases, etc., could only have been formed in this way. He does not, however, find any pottery of the mound-builders that would lead to the belief that their skill went so far as to enable them to mold it in parts, or to fashion it in any other way than by the hands.

(144)

NEW AND BEAUTIFUL DIATOMS.



NEW DIATOM.—(TRICERATIUM FAVUS.)

F. KITTON has recently placed before the Royal Microscopical Society some new and rare forms of Diatomacæ, obtained from dredgings made near Panama. Of one of these, *Triceratium Favus*, we give a magnified sketch. The extreme breadth of the original is one-fiftieth of an inch; enlarged by the microscope to about 3 inches, it presents the appearance shown, and is figured in the *Microscopical Journal.*

NATURAL HISTORY AT PENIKESE.

PROF. F. W. PUTNAM has given a very interesting account of the progress of the Anderson School of Natural History on Penikese Island, a task for which he is admirably fitted on account of his prominent position as an instructor on the island.

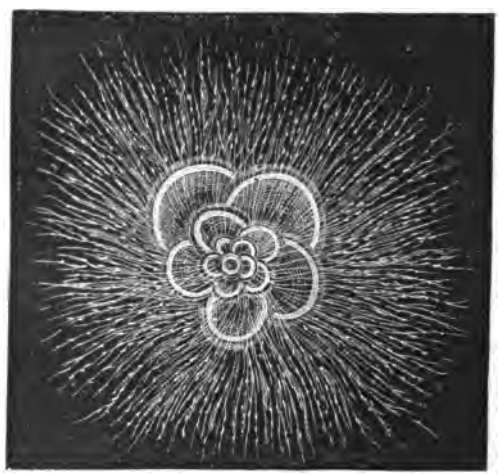
Some 40 pupils admitted last year were readmitted this year, but the majority were new hands coming to school for the first time, and we had the opportunity of trying the experiment of teaching them in a certain manner—the general principle upon which I think the school will in future be established. It is, first, that all the teaching done there shall be done from the specimens. Text-books are not allowed. We at first labored under a disadvantage in this way—that the pupils were entirely made up of teachers throughout the country. The persons having the first right are teachers who have the subject of natural history assigned to them in the various schools. The point was to get them to use their eyes, so that when they returned to the text-books they would use them with a feeling of confidence that they would know whether the text-book was correctly defining the subject upon which they were teaching or not. Our way was to give each student a specimen of fish and ask him or her to study that fish, and tell the instructor what had been observed. Thus we developed their powers of observation upon the external character of the fish.

After they had studied the fishes for about two days, they were called upon to state what they had seen. Then the anatomy of the specimens was gone into, and the students were led on, step by step, until they had secured a very firmly founded idea of the structure of a vertebrate animal. Then we asked questions as to the character of vertebrate, and finally they began to be original investigators. We really demonstrated in a practical way the subject, which is exciting so much attention just now, of co-education of the sexes. We found that the ladies of the school were as capable in every way of making careful dissections and rendering careful accounts of the work they had done as the gentlemen, and, in fact, four or five of the ladies became original investigators before any of the gentlemen. This showed conclusively that the ladies had the power of becoming original investigators in science, if they only would give the application.

Prof. Putnam spoke enthusiastically of the buildings which comprised the school, ranking them with the best for the purpose. He also described how the lessons in drawing were conducted by Prof. Ritter, and concluded

with the remark, "I believe not only that this school will be a great success in giving teachers proper knowledge, but will do an immense amount of good in advancing science, by preparing teachers of it to properly teach their pupils."

THE GLOBIGERINA.



THE GLOBIGERINA.

THE engraving given herewith is a highly-enlarged representation of a microscopic protozoan animal found in immense numbers on the bottom of the ocean, and existing at depths of over 10,000 feet. It increases by budding, each sarcode mass being enveloped in its calcareous cell, but connected irregularly with the rest of a colony. There is no definite shape, the mass being compared by Huxley to that of a badly-grown raspberry. According to D'Orvigny, in a single ounce of sand dredged up in the neighborhood of the Antilles no less than 3,810,000 shells of the animalculæ have been counted.

The most extraordinary feature of the organism are its pseudopodia, or curious thread-like processes which extend through the minute openings in its shell. When the animal is hungry it throws out these filaments in all directions, as represented in the engraving. As soon as the corpuscle which serves as its food comes within reach, the

threads wind themselves about it and carry it down against the body of the animal, pressing the prey against the gelatinous mass until entirely absorbed.

At other times the pseudopodia are drawn in, and the Globigerina remains motionless until it desires to change its position. The filaments again emerge, this time, however, not singly, but seemingly aggregated into one large foot, by the aid of which the animal propels itself. The work accomplished, the foot disappears, and no trace of it can be detected in the organism.

It is certainly a most astonishing fact that this microscopic animal, little more than a mere stomach, depends for its nutrition and locomotion upon entirely unorganized members. When it wishes food or to move, it evolves an organ for the purpose—for the members used are not found in the mass of the body when absent from the exterior.

WINGS OF THE PTERODACTYL.

By Prof. O. C. Marsh.—Prof. Marsh described first the geological position of the pterodactyls, or flying dragons. These occur only in the secondary rocks. The oldest are found in the lias of Europe, and the whole group are becoming extinct at the end of the cretaceous formation. Some of these are very small, hardly larger than a robin. The first found in this country, and the largest known, were discovered in the cretaceous beds of Kansas, having a spread of wings of 25 feet. For the last half century there has been a discussion as to the affinities of these reptiles, and also in regard to the nature of the anterior extremities. Cuvier and many other naturalists said they were organs of flight—true wings. Some German naturalist, and Prof. Agassiz in this country, contended that they were used for swimming, like the paddles of a turtle, and that the animal was essentially aquatic. It often happens in science that, after a long discussion as to the nature of some animal or some point in science, a single discovery settles the whole question, and the specimen which Prof. Marsh exhibited has put an end to all discussions on that point. As shown in this specimen, which was found in the quarries of Bavaria, the wings are perfectly exhibited, and it is shown clearly that they were very similar to those of the bat, having a thin membrane stretched on the elongated little finger, and extending to the point of the elongated tail. This specimen is by far the most perfect ever discovered, and promises to clear up several other difficulties beside the question about the nature of the wings. Prof. Marsh detailed with particularity the character of these true wings, and remarked

that this specimen was now in the Museum of Yale College, and also the remains of three species found in this country, all of which he hoped still to describe in full, with illustrations. (144)

HOW BIRDS GET OUT OF THEIR SHELLS.

SHOULD anybody, says Prof. J. W. P. Jenks, remove the shell and examine the animal beneath the membrane of a chicken about to hatch, he would find difficulty in believing that the bill was used to break a passage. Prof. Jenks found a robin in the act of hatching. There was no room for entire movement of the mandibles; he saw the lower mandible only, used to puncture the shell. This was thrust forward on a line all around the egg, cutting it in two. The upper mandible did not follow the lower until the lower had cleared the way. More frequently than otherwise, immediately after the hatching, in the case of large birds like spoonbills, they were found to have left the two halves of the shell fitting one within the other. How this was brought about Prof. Jenks could not say—whether this was the work of old birds, to save room in the nests, or was in some way effected by the young in the act of hatching; but there was abundant evidence of the fact in question.

A LADY NATURALIST.

AMONG the members present at the meeting of the American Association for the Advancement of Science, at Hartford, Ct., August, 1874, was Mrs. Almira Lincoln Phelps, who presented a memoir on the Progress of Science in Maryland, which was read by Prof. Morse. Mrs. Phelps, a white-haired, pleasant-faced, very elderly lady, is well-known as the author of Lincoln's Text-Book of Botany—written when she was Miss Lincoln—which most of us recollect as a school-book in our younger days. Mrs. Phelps was present during the reading of her paper, which received general applause. At its conclusion, Prof. Morse said:

"It has been a pleasure and an honor to have read this communication from one of our most esteemed members, and one whom we all highly respect. A rare sight it is indeed to see a lady past eighty with mind clear, and brain active on all questions of science, and with sound physical health which enables her to travel a long distance to participate in the exercises of this meeting. The activity of her life is seen in the number of charming works of a more general character, which have issued from her pen beside essays, reviews, and addresses."

METEOROLOGY AND TERRESTRIAL PHYSICS.

THE SOLAR COUNTER.

A CURIOUS invention, the device of Abbé Allegret, has recently been introduced in the *Jardin d' Acclimation*, in Paris. It is an instrument which indicates how long the sun shines (months, days, hours, and minutes), during any given period. The machinery operates only when the sun is visible, and transmits its movement to three dials, which, connected together in a simple manner, show months, days, hours, and fractions of the latter.

The essential part of the apparatus is two balls, one of which is black and the other yellow, fastened on opposite arms of a lever, which is sustained by a central pivot. When the sun shines the black ball absorbs more heat than the yellow one, and hence the vapor of the liquid contained in the former is elevated to a higher temperature than that in the latter; consequently the fluid travels through the lever from the first ball to the second, which, becoming heavier, overbalances the equilibrium, and in so doing sets free a weight attached to clock-work mechanism connected with a pendulum. When the sun is obscured, the liquid resumes its normal position, and the arms of the lever once more balance, arresting the fall of the weight.

In addition to the three dials above noted, there is a fourth, which is combined with mechanism which shows how many clouds pass before the sun, how frequently, and the exact time they take in making the transit. This consists of a narrow band of paper extended on a light circular frame established around the face of the clock. The latter is actuated by the ordinary machinery. Its single hour hand carries a pencil. When the sun shines, the paper, on its movable frame, is carried up to the pencil through mechanism connecting with the motor already described. The leaden point then traces a portion of the circumference corresponding to the divisions on the face of the clock passed over by the hand. If, however, a cloud passes before the sun, the movement of the lever, regaining its balance, withdraws the paper circle from the pencil, leaving a blank, the length of which shows the time during which the sun was screened. A single band of paper will last for a month or more, as the hour hand is made in two parts, screwed together, and so combined

that, at every revolution, the outer portion passes under a fixed rack so that the screw head is slightly turned, thus elongating the arm and causing the pencil to begin its mark on a fresh portion of the paper.

In connection with the apparatus, the inventor has established a sun dial which strikes the hours, a paradoxical operation accomplished as follows: At every hour-mark on the dial plate is fixed one of the ball and lever mechanisms that we have above described. When the shadow of the style arrives at any hour, one ball is shaded, the lever tilts, and clock-work mechanism, of simple construction, strikes the hour on a gong.

THE COLD COAST CURRENT.

DR. CARPENTER, in illustration of the physical theory of under-currents, exhibited before the British Association a sectional map of the sea between Nova Scotia and the Bermudas, and including the isothermal lines. These lines were tilted up at the western end, indicating the existence of a cold current between the American coast and the Gulf Stream. This fact was interpreted by Dr. Carpenter as due to the rotation of the earth, combined with the fact that this cold water is flowing from north to south. A similar phenomenon is met with on the east coast of Japan, where there is a cold band between the Japan current and the land, and also in the North Sea, where there is glacial water within 100 miles of the north coast of Scotland.

The existence of this cold current on the east coast of North America, extending down even to the coast of Massachusetts and beyond, is well known to American marine zoologists, the parties working in connection with the United States Fish Commission in 1872 and 1873 having obtained, at various localities, at depths of 75 to 120 fathoms, temperatures as low as 35° Fahr.

OUR ATMOSPHERIC DUST.

M. TISSANDIER has lately been prosecuting extended inquiries into the character and amount of atmospheric dust precipitated upon given surfaces, and finds occasion to conclude that this amount is quite enough to play an important part in the physics of our globe. This dust he found to contain one-third of combustible organic matter and two-thirds of mineral matter. Iron is almost always present, and this, in M. Tissandier's opinion, has an important bearing upon the question of iron meteorites. He thinks, also, that a considerable part of this atmospheric dust is received from the planetary space.

CHILI.

MR REED, after a residence of four years in Chili, sends to the Bristol Naturalists' Society an interesting account of the physical geography and botany of that country, from which we take one or two items that may, perhaps, be novel. The volcanoes of the Chilian Andes are all to the south of Santiago. The altitude of the snow-line in the latitude of Santiago is estimated at 11,000 feet, but is frequently, according to the author, as high as from 13,000 to 15,000 feet. At a height of between 11,000 and 15,000 feet large patches of snow, possibly forming glaciers, have been noticed by him. The wind at midday on the mountain-tops is so strong that it is considered prudent to cross the mountains early in the morning. The height of the Andes affects the rain-fall, by depriving the east winds of a large amount of moisture. North of latitude 35° south the rain-fall at the coast is fron 7 to 22 inches annually; but in latitudes 40° and 41° it amounts to from 105 to 115 inches. With regard to the desert of Atacama, Mr. Reed states that we have no reliable knowledge of its rain-fall, but, judging from the best information extant on the subject, it rains about twice in a century, according to one authority, or twice in a decade, according to another.

ICE CRYSTALS IN THE AIR.

M. WALDNER, Professor of Mathematics at Osthofen, Germany, while engaged in examining the solar spots some years ago, had his attention attracted to an immense number of small white particles which suddenly came into view on a casual change in the position of his telescope. He at once began investigations, in order to discover their nature; and, after continuing his researches for some three years, he found that the bodies appeared like snow-flakes, which floated, like the clouds, in aerial currents, and existed at differing altitudes. He finally determined them to be ice crystals which were driven by the winds at the same velocity as the cirrous clouds.

Mr. J. Francis Anderson has recently devoted his studies to this subject, and he explains the presence of the particles by the fact that the vapor of water tends to rise in the atmosphere. As it ascends it meets cold strata of air, condenses into water, and then freezes into solid bodies which are simply snow-flakes. In the lower portions of our atmosphere, however, there are other luminous corpuscles which principally consist of organic material. These are easily observable by allowing a beam of sunlight to enter a darkened room, or may be seen out of doors by

simply cutting off the disc of the sun with an opaque object. By means of these bodies in the inferior strata, and the snow crystals in the upper regions of air, Mr. Anderson considers that the direction of the wind may be determined at any altitude, even during a cloudless day. He proposes simply to adjust a telescope so as to give distinct vision at two, three, or more thousand feet, and to note the direction and rapidity of the particles, which will then be clearly seen as they cross the field of view. This will give the direction of the current which carries them along, and its approximate velocity for whatever altitude the instrument may be adjusted for.

ELECTRICAL TIME.

THE telegraphic apparatus at the Naval Observatory at Washington is now connected with the main lines of the Western Union Telegraph Company, so that not only is the time ball dropped daily at noon, but the same signal is widely distributed by the telegraph company. It goes directly from the observatory to the main office in New-York city, and thence it is sent to nearly every State in the Union. The immediate object of these signals is to furnish accurate and uniform time to the railroads, and throughout the whole of the vast territory in question there is scarcely a train whose movements are not regulated by the observatory clocks. The clocks at the Navy Department, at the Army Signal-office, at the Treasury Department, and at the Western Union Telegraph Company's office, are all constructed on the system known as Hamblett's, and are directly controlled by electric currents sent every second by the standard clock at the observatory.

FACTS ABOUT STORMS.

FROM the United States weather maps, Professor E. Loomis has made an extensive series of deductions, deriving many interesting facts:

The average direction of the storm paths for two years was N. 82° east, or 8° to the north of east, and the average velocity was 25.6 miles per hour; but there is a noticeable variation, both in the direction and velocity, depending upon the season of the year. The course of storms is most southerly in summer, and it is a little less northerly in winter than it is in spring or autumn. July is the month in which the course is most southerly, and October is the month in which it is most northerly, the mean difference between these two months amounting to 33°. The velocity of progress is greatest in winter and least in summer.

The diversity in respect to the velocity of progress of particular storms is still greater. In some cases a storm-centre has remained sensibly stationary for 24 hours, and occasionally still longer, while in four cases a storm-centre has advanced over 1,200 miles in 24 hours, and in one case, May 15, 1872, the average velocity for 24 hours amounted to 57.5 miles per hour. Thus the velocity of progress ranges from zero to 57.5 miles per hour.

The storm path may have every possible direction, and the velocity of progress may vary from 15 miles per hour toward the west to 60 miles per hour toward the east.

The fall of rain appears to have a decided influence in modifying the course of a storm path.

Every considerable depression of the barometer is accompanied by a fall of rain, and the area of rain-fall usually extends further on the eastern side of a storm-centre than it does on the western side. The average extent of the rain area on the east side of the storm's centre is 500 miles.

The fall of rain, that is, the precipitation of the vapor of the atmosphere, is generally accompanied by a fall of the barometer. According to the theory advocated by the late Mr. Espy, when the vapor of the atmosphere is condensed, its latent heat is liberated, which raises the temperature of the surrounding air, causing it to expand and flow off laterally in all directions in the upper regions of the atmosphere, thus causing a diminished pressure over the region of precipitation, and an increased pressure on all sides beyond the area of the rain.

The progress of the storm eastward is not due wholly to a drifting resulting from the influence of an upper current of the atmosphere from the west, but the storm works its own way eastward in consequence of the greater precipitation on the eastern side of the storm. Thus the barometer is continually falling on the east side of the storm and rising on the west side, in consequence of the flowing in of colder air upon that side. The stronger the wind on the west side of the storm, the less is the velocity of the storm's progress.

Some persons might have anticipated that an increase in the velocity of the wind in the western quadrant of a storm would have the effect of driving the storm eastwardly more rapidly ; that is, of increasing its velocity. But upon each side of a storm's centre the wind blows obliquely inward, and hence we must infer that in the central region of the storm there is an upward motion of the air; and this is the cause of the precipitation of vapor,

that is, the cause of the rain-fall. An increase in the velocity of the wind in the western quadrant is accompanied by an increase in the velocity of the upward motion in this quadrant, that is, an increase of precipitation. This increased precipitation of vapor tends to depress the barometer on the western side of the storm, that is, tends to retard the eastward motion of the storm's centre; and this cause may operate with sufficient force to carry the storm's centre westward, as actually happened in several instances in the years 1872 and 1873. On the other hand, an increase in the velocity of the wind in the eastern quadrant tends to produce a greater precipitation on the eastern side of the storm's centre; that is, tends to push the storm's centre eastward, or increase the velocity of its progress.

THE TEMPERATURE OF THE OCEAN.

DR. CARPENTER recently delivered a lecture before the London Royal Institution on the "Temperature of the Ocean," showing, from the soundings made by the Challenger expedition, that the difference of climate between Northwestern Europe and the North American Atlantic seaboard is due not to the course of the Gulf Stream, but to the circulation of the waters of the ocean between the poles and the equator. The shores of Northwestern Europe have the benefit of the northward movement of the warm superficial stratum, while the temperature of the American coast is lowered by the surging up against it of deep glacial underflow. The fact, he says, comes out most clearly from the Challenger soundings, which had been suspected by the United States Coast Surveyors, that the cold band which separates the Gulf Stream from the United States coast is really continuous with the cold strata that lie at some depth beneath the Gulf Stream, and this continuity explains the presence of the cold band which was previously wanting. For, as any flow of water from the equator toward either pole will tend toward the east, in virtue of the excess of easterly momentum it brings from a part of the globe where its rotation was rapid; so any flow of water proceeding from either pole toward the equator will tend toward the west, in virtue of that deficiency of easterly momentum which it derives from a part of the globe where its rotation was less rapid. In this surging upward of the deeper and colder stratum lying beneath the Gulf Stream, we have very distinct evidences of its southerly movement. The precisely similar cold band which has been observed by Captain St. John to separate the Kuro Liwo, or warm Japan current, from the coast, may be fairly attributed to the same cause.

DUST IN ARCTIC ICE AND SNOW.

M. NORDENSKJOLD has recently found, in the ice and snow of the Arctic polar sea, a black dust. This he had melted, and subsequently submitted it to chemical analysis, which has proved that it is composed of nickel and cobalt, and similar in constitution to the meteorites. It seems probable, therefore, that the powder is actually due to the disintegration of these aerial bodies at a short distance from the earth.

The regions which this intrepid traveler has lately explored are the most inhospitable on the globe. He has traversed ice-seas, the level of which rises to over three thousand feet above that of the ocean, and which are rent with huge crevasses often entirely concealed by snow and fog, rendering their exploration an enterprise of the greatest danger. M. Nordenskjold is organizing a new expedition, to start in the spring of 1875.

CLIMATE OF ALASKA.

THE *Service Monthly*, in an interesting chapter upon Alaska, gives a few items regarding the weather that will be of interest to those who do not appreciate the peculiarities of that climate. At Sitka the mean temperature of summer is 54°, and that of winter is 32°, the latter being precisely the mean of St. Louis, Missouri. In place of incessant hail and snow, as is frequently erroneously supposed, rain falls throughout the winter season, and whatever snow falls soon disappears. Not only do these thermal conditions exist at the capital of Alaska, but a proportionally high temperature reigns throughout the coasts beyond, and the influence of the ocean currents extends even to Norton Sound, near the arctic circle. In the Aleutian Islands the winters are somewhat colder, but the temperature frequently remains above 35° until the 1st of January. On Kodiak Islands the two most severe frosts of one winter were recorded at 0° and 13°. The Greek Bishop Veniaminoff, who has kept a continuous record for six years, states that during that interval only on nine occasions did the mercury fall below 10° Fahr.; but on the other hand the summer temperature averages only 49°, and the line of perpetual snow on Maskushin, an active volcano in Oonalaska, has an elevation of 3,100 feet. The arctic winter in the interior at Fort Yukon yields a mean temperature of 30°, but the mean temperature of July is frequently as high as 65° or 70°. From December to April the average number of days on which rain or snow falls in the Aleutian Archipelago is twenty-six per month. The mean temperature of the winter months on

the island of St. Paul is 20°, or very nearly the same as at Omaha and Northern New-York. Fog prevails almost incessantly in the autumn. Iceland in the North Atlantic and St. Paul in the North Pacific, or Behring Strait, present respectively two areas of low barometer.

LIGHTNING AMONG A FLOCK OF GEESE.

A SINGULAR occurrence, which took place last Spring in the northern part of Sutter and the southern part of Butte counties, Cal., is narrated as follows in the *Sutter Banner*: "Just before sunset, a large thunder-cloud came up, apparently from the northeast, accompanied by an unusual amount of chain-lightning. First a small amount of hail fell, and then followed sufficient snow to whiten the ground. As the hail began to fall and the lightning flashed, thousands of wild geese, which were in the ponds of shallow water which exist in that locality during very wet winters, suddenly rose up in a great flutter, as if many hunters had discharged a volley among them. They went up and up, apparently to rise above the fearful cloud. It was nearly dark, and those who saw them rise thought no more of it until morning, when they began to find dead geese, and hear of hundreds being picked up by the neighbors. Some 700 were found. One man picked up on his farm all that two horses could haul. Their heads were badly torn, and their bills split into fragments. The portion of the country thus affected was about a mile and a half wide, and reached several miles into Butte county. The terrific lightning in this cloud was witnessed by the people on the Honcut, in Yuba county, and in the central portion of Sutter. The thunder was heard at the distance of twenty miles."

NEW APPARATUS FOR REGISTERING CLOUDS.

M. DE PARVILLE proposes for this purpose a board some 12 inches long by 8 inches broad, fixed on a suitable support. A square of unpolished glass, placed vertically, divides the plane in two equal parts. The left hand side of the latter is covered with a mirror; on the right is a sheet of paper. As the clouds pass above the horizontal glass, they are reflected; and at the same time the observer sees their images on the vertical glass projected on the paper. It is only necessary to trace their direction on the latter with a pencil. On the mirror is engraved a compass card, which is also reproduced on the paper, and a small magnetic needle is suitably arranged so as to adjust the apparatus.

GEOGRAPHY.

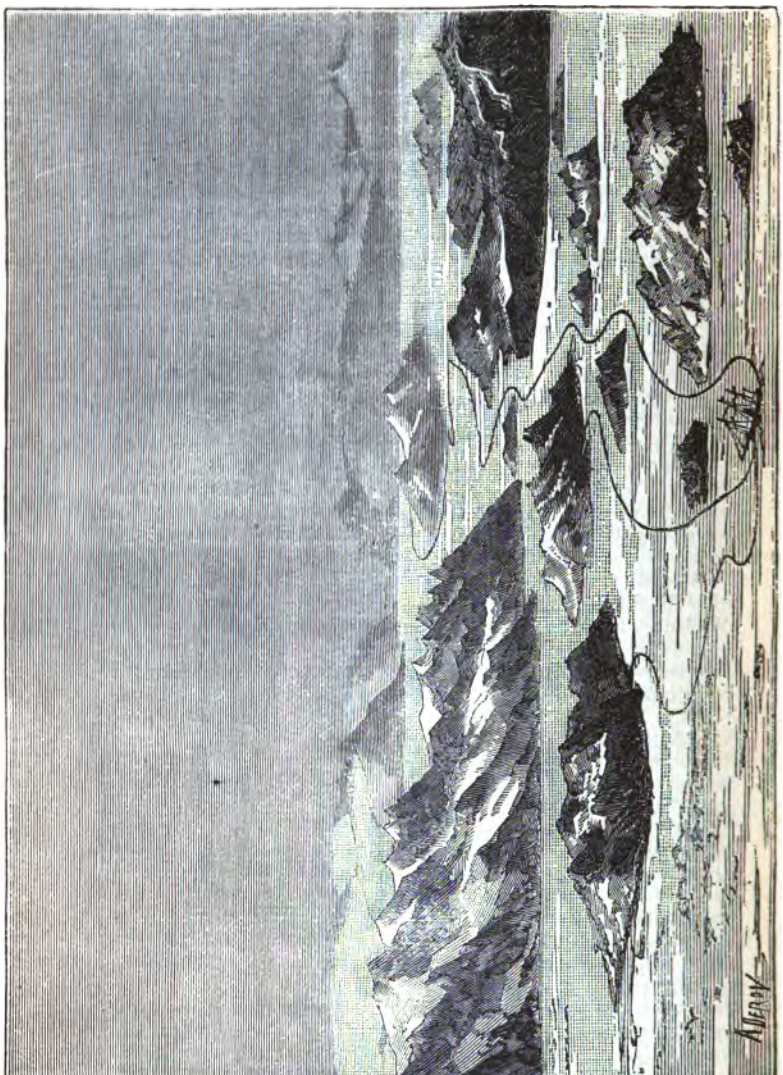
THE AUSTRIAN POLAR EXPEDITION.

THIS North Pole Expedition left Bremerhaven on June 13, 1872, in the steamer "Tegethoff." In August the ship was ice-bound, and never was got out again. The temperature sank, copious snow-falls cemented the loose ice-fields, and the "Tegethoff" was surrounded by a solid mass of ice.

In this precarious state the ship lay for five months, the ice freezing together and bursting in turn, and so exposing it perpetually to fresh pressure. All was prepared for leaving the ship. The stores were brought on deck, and a portion placed on the ice. This was the most trying time of the whole. Every moment the alarm was sounded and the signal given for leaving the ship. It was sufficient to wear out the strongest. In spite of this, meteorological and other observations were carried on. The strain on the mind told on the state of health in spite of all precautions, and scurvy and pulmonary affections set in.

All this time the ship was being driven in a northeasterly direction until, towards the end of January, 1873, 73° W. long. and 79° lat. were reached on February 25. The sun appeared again after five months on the horizon, and on the 25th the pressure of ice ceased. A massive wall had been formed round the ship, protecting it from further injury. The drifting was now to the northwest. Milder weather having set in, the hope revived of setting the ship free, and for five months the work went on. By dint of boring and blasting, the fore part of the ship was made free, but to free the aft proved impossible, ice of 30 feet thickness lying underneath.

Disheartened, the expedition had almost resigned itself to have to pass another winter in the same position, when, on the 31st of August, 1873, high land was seen in the north, some fourteen nautical miles off. The feeling at first of great joy at the unexpected discovery became soon a torture, to be so close and not to be able to get to that unknown land. At last, toward the end of October, the ship drifted to about three miles off one of the islands which lay before the main land, and there the ship froze in at the beginning of November, 1873, and lies



THE NEWLY DISCOVERED POLAR LANDS.

still in 79° 15′ N. lat. and 58° 36′ W. long. Here the winter of 1873–4 was passed in comparative quiet.

During the time a series of highly interesting astronomical, meteorological, and magnetical observations were made. The Northern Lights were very numerous and magnificent—white, red, and green, with crowns, bands, and rays of great size and brilliancy. The needle was so disturbed that oscillation became the rule and steadiness the exception. The cold was more intense than the year before, there being 37° Réaumur below zero on the ship, or 51° F. But the supply of fresh bear's meat, and the absence of that strain on the mind produced by constant danger, kept the crew in better health. The reappearance of the sun on the 24th of February, 1874, did the rest. The explorations had already begun.

A first expedition of Payer, the two Tyrolese, four sailors, and the only three dogs remaining, started for the main land, went up the promontories named Tegethoff and M'Clintock, 2,500 feet high, and up the Nordenskjold Fjord, bordered by the large Souklar glacier. It was still very cold, 40° Réaumur, and all was white with snow and hoar-frost, making the symmetrical rock columns look like candied sugar.

The second expedition of thirty days started on the 24th of March, 1874. The temperature had risen, but snow-drifts, wet, and the breaking up of ice, made the journey still more dangerous. The progress became more and more difficult and dangerous; it was all fresh ice, often not more than a few inches thick. From Cape Fligely, the most northerly point touched, another elevated point, named Cape Wien, was sighted in 83°, the most northerly point of the known earth. Then the journey back again was more dangerous than the advance, but on the 25th of April, 1874, the ship was seen on the spot where it had been left.

After a few days' rest, very much wanted, a third expedition was made, again to the west—like the first—when a high mountain, Cape Brünn, 40 miles from the ship, opened out a view over the mountainous country, with the Humboldt Peak, about 5,000 feet high, as its culminating point.

Already, in March, a council had been held, and the decision had been come to to abandon the ship and to try to make their way back on sledges and boats. On the 20th of May, 1874, the colors were nailed to the masts of the ship, and the expedition started with three boats and as many large sledges. The exertions proved almost too much. The journey had to be made five times over, three times tugging at boats and sledges, then twice back again.

The continual south wind driving the ice northward seemed to make all efforts to get south useless, and after eight months' toil it seemed as if nothing remained but to return to the ship and pass there another winter. In the second half of July, however, north winds set in with rain, loosening the ice and breaking it up, until, on the 13th of August the expedition got into free water. It was in the unusually high latitude of 77° 40′. Had it not been for this exceptionally favorable state of the ice, the impression is that the expedition would not have been able to return. Now there was the pulling for the land. The crews and officers, divided into two watches, took it in turn day and night, so that forty miles' progress was made daily. However, on the 29th of August, 1874, two fishermen were sighted in a boat belonging to the schooner "Nicolay," which had brought the expedition to Vardöe, Norway, on the 2d of September.

The new land, as far as discovered, is about the size of Spitzbergen, and consists of several large masses intersected by fjords and surrounded by islands. A large passage called the Austria Sound separates these masses and forks under 82° north latitude into a northeasterly arm, which could be followed up to Cape Pest in the furthest north. The mountains are dolomitic. Their middle elevation is from 2,000 to 3,000 feet, only toward the south they may rise up to 5,000. All the depressions between the summits are occupied by glaciers of gigantic size, as they only occur in arctic regions. The vegetation is much poorer than that of Greenland, Spitzbergen, or Novaya Zemlya, and in the south, except for Polar bears, it is devoid of animal life too. Several attempts were made to pass through the country, but they were found impossible; mountains barred the road, so progress was tried along the coast line, and the more the explorers penetrated north by west the more the temperature rose, and the coasts of Crown Prince Rudolf Land were found to be tenanted by myriads of birds, elks, etc. Traces of bears, foxes, and hares appeared, and seals lay on the ice. In spite of the treacherous nature of the road, it was continued to 82° 5′, where, at Cape Fligely, a wide expanse of water only covered with ice of recent formation was seen. In spite of this, the explorers think the open Polar sea a delusion. Without raising a theory about the possible connection of this new land with Gillis Land in the southwest, the opinion is that it bears out up to a certain point Petermann's assumption of an inner arctic archipelago.

The fact of the expedition having found *hares* in the newly-discovered land seems significant of a channel, not

invariably frozen in winter, between Franz-Joseph Land and Spitzbergen, since hares do not occur in the latter.

In Norway the members of the expedition were received with the greatest enthusiasm, at Hamburg they were welcomed like bringers of good tidings, and on their entry into Vienna they could not have received a greater ovation had they been the remnant of a conquering army. All this they have richly merited, and there can be no doubt whatever that Lieutenants Payer and Weyprecht have won for themselves a place in the first rank of arctic explorers.

A second Austrian Arctic Exploring Expedition is to start in the summer of 1875. The British Government will also soon send out an Arctic Expedition.

Our illustration, prepared from a chart recently issued by Dr. Petermann, represents the strange region discovered by the Austrian Polar Expedition.

On the right and in the middle distance is Wilczek Land, so-called in honor of Count Wilczek, the organizer of the expedition. The northwest coast of this immense island is bordered by great glaciers, which extend as far as the eye can reach toward the Asiatic side. Opposite and on the left of the picture is Zichy Land, also named after one of the patrons of the enterprise, upon which is located Mount Richthofen, the elevation of which, some 5,000 feet, renders it the highest point in the vicinity. The explorers did not visit either Wilczek or Zichy Land, as will be seen from the tracing of the courses of the three voyages made in March, April, and May of 1874. The longest expedition was undertaken in April, and extended to the 82° parallel of N. latitude, and about the middle of the sea to the north of the two large islands above mentioned.

The first journey made in March was begun after the "Tegethoff" was blocked in the ice, and is represented by the middle tracing. The explorers reached Prince Rudolf Land, and then were obliged to return. The second and longest effort resulted in the discovery of two points of land between which a promontory could be discerned, to which the name Cape Vienna was given. The region on the east, which was made out to be an island, was afterwards named Petermann Land, and the opposite shores Prince Oscar Land. The strait between was filled with ice, but it was conjectured that at a proper season of the year a vessel might possibly be able to force a passage, and so reach Cape Vienna.

The third expedition was to Mount Brünn—left foreground of the engraving—from the elevated portions of which the explorers noted another region of country some

60 miles to the westward, which they believed to be Gillis Land, discovered by Scandinavian mariners in 1707.

The passage toward Cape Vienna is probably a gateway toward the pole; but that it will ever be successfully penetrated, the reports of the explorers hold out little promise. Indeed, it seems that the difficulties of Arctic exploration increase in proportion as northward progress is made. (47) (121)

DEATH VALLEY.

ACCORDING to the recent expeditionary report of Lieutenant Wheeler, the Death Valley in California is a detrital sink of unique physical characteristics. This whole region presents a series of valleys or detrital plains, each entirely inclosed by the ridges of Cordilleras that are more or less distinct as a series of mountain masses. The Death Valley proper is one of the most remarkable of all known interior continental depressions, and has portions near the centre of its axial line below the level of the sea, although far inland, and lying much to the north of the lower border of the great interior basin. It is the sink of the Amargosa River, whch has its source in the areas of drainage formed to the south and east of Belmont, Nevada, traverses the desert of that name while passing southward, until, reaching latitude 35° 41′ 5″, it makes an abrupt angle to the west, and thence, at right angles to the north, reaches the point of greatest depression, a little less than 500 feet below the sea level, in the heart of Death Valley proper. This valley, of the ordinary oval form, is fully 70 miles in length, varying from 5 to 15 miles in width, surrounded by frowning mountains of volcanic and sedimentary origin, the Telescope range rising higher than 10,000 feet. The line crossing this dismal area from the mouth of Death Valley cañon to the thermal springs in Furnace Creek, presenting a labyrinthine maze of efflorescent, saline forms, creates at the level of vision a miniature ocean, the vibrations of whose contorted waves has a sickening effect upon the senses. The lurid glare, horizoned by the bluish haze radiated from the mountain sides, appears focussed to this pit, though broad in expanse. It seems, coupled with the extreme heat, to call for the utmost powers of mental and physical endurance.

The journey through the Valley of Death occasioned the utmost apprehension, evinced through the entire season. To this was added the effect oi the fearful cloudburst experienced while among the Telescope Mountains, to the west, and the absence of the guide who had ven-

tured toward the northwestern arm of the valley, it was feared, to return no more. The transit of 48 hours, in a temperature that remained at 117° Fahr. at midnight, so exhausted both men and animals that further travel was rendered precarious.

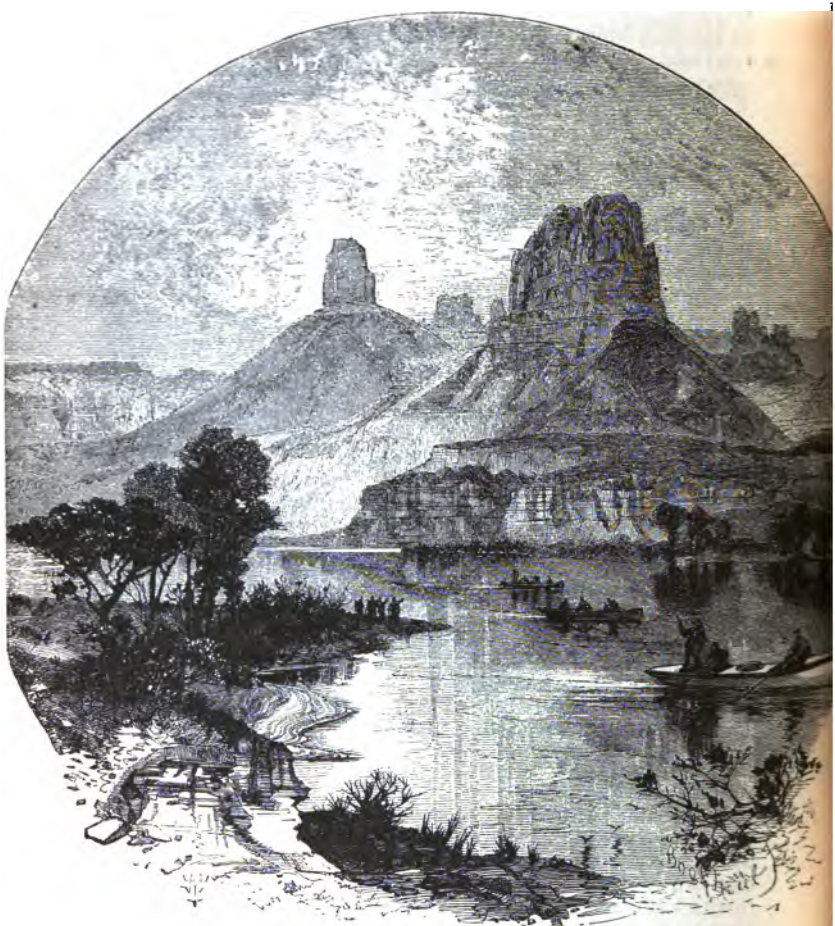
SCIENTIFIC RESULTS OF THE POLARIS EXPEDITION.

THE report of the voyage of the Polaris, issued from the Government printing-office, contains a memorandum by Dr. Bessel on the scientific results and discoveries of the expedition. Large numbers of astronomical observations were made, but the records were all lost, with the exception of a few of little value. Soundings were taken along the coast of Grinnell Land, which proved that the hundred fathom line follows the coast at a distance of about fifteen miles from Smith's Sound. One of the casts brought up an organism of still lower type than the *bathybius* discovered by the English dredging expedition. It was called the *protobathybius robesonii*. The aurora was frequently observed, but it never appeared with sufficient brilliancy to produce a spectrum. The most careful examinations failed to show any electricity in the atmosphere. The land was covered by drift, the main line of which, indicating its motion, runs from north to south.

Although the details of the discoveries are very meagre, and, owing to the loss of specimens as well as records, nothing can be done to amplify them, Dr. Bessel believes that the voyage has not been without results of the highest importance. These he summarizes as, first, the fact that the Polaris reached 82° 16′ N., a higher latitude than has been attained by any other ship; second, the navigability of Kennedy Channel has been proved beyond a doubt; third, upward of 700 miles of coast line have been discovered and surveyed; and, fourth, the insularity of Greenland has been demonstrated.

AN AMERICAN RIVER NILE.

THE valley of the Rio Grande del Norte, in New-Mexico, recalls the features of the Egyptian Nile. A large population is entirely dependent upon the river. An annual rise of the waters carries a muddy sediment, superior in fertilizing properties, as was proved by analysis, to that of the great African river. While the amount of phosphoric acid is nearly the same, the amount of potash is considerably higher. Thousands of acres are lying idle along the valley of the stream, awaiting the enterprising farmer.



THE CAÑONS OF THE COLORADO.—GREEN RIVER.

THE CAÑONS OF THE COLORADO.

By Major J. W. Powell—The Colorado River is formed by the junction of the Grand and the Green. Grand River has its source in the Rocky Mountains, five or six miles west of Long's Peak, in latitude 46° 17′ and longitude 105° 40′, approximately. A group of little Alpine lakes that receive their waters from perpetual snowbanks discharge into a common reservoir known as Grand Lake —a beautiful sheet of water, whose quiet surface reflects towering cliffs and crags of granite on its eastern shore, and stately pines and firs on its western margin.

Green River heads near Fremont's Peak in the Wind River Mountains. This river, like the last, has its sources in Alpine lakes fed by everlasting snows. Thousands of these little lakes with deep, cold, emerald waters, are embosomed among the crags of the Rocky Mountains. These streams, born in the gloomy solitudes of the upper mountain region, have a strange and eventful history as they pass down through gorges, tumbling in cascades and cataracts until they reach the hot, arid plains of the lower Colorado, where the waters that were so clear above, empty muddy floods into the Gulf of California.

Green River is larger than the Grand, and is the proper continuation of the Colorado. Including this river, the whole length of the stream is about two thousand miles. The region of country drained by the Colorado and its tributaries is about eight hundred miles in length, and varies from three hundred to five hundred in width, containing about three hundred thousand square miles—an area larger than all of New-England and the Middle States, with Maryland and Virginia added.

There are two distinct portions of the basin of the Colorado. The upper two-thirds of the basin rises from four to eight hundred feet above the level of the sea. This high region is set on the east, north and west, with ranges of snow-clad mountains attaining an altitude above the sea, varying from eight thousand to fourteen thousand feet.

The lower third is but little above the level of the sea, but here and there ranges of eruptive mountains rise to an altitude of from two to six thousand feet. This part of the valley is bounded on the north by a line of cliffs which forms a bold, often vertical step, hundreds or thousands of feet, to the table-lands above.

Very little water falls within the basin, but, all winter long, snows fall on its mountain-crested rim, filling the gorges, half burying the forests, and covering the crags and peaks with a mantle woven by the winds from the

THE CAÑONS OF THE COLORADO.—GATE OF LODORE.

waves of the sea. When the summer sun comes, these snows melt and tumble down the mountain-side in millions of cascades. Ten million cascade brooks unite to form ten thousand torrent creeks; ten thousand torrent creeks unite to form a hundred rivers beset with cataracts; a hundred roaring rivers unite to form the Colorado, which rolls a mad, turbid stream into the Gulf of California.

Consider the action of one of these streams, its source in the mountains where the snows fall, its course through the arid plains. Now, if at the river's flood storms were falling on the plains, the channel of the stream would be cut but little faster than the adjacent country would be washed, and the general level would thus be preserved; but, under the conditions here mentioned, the river deepens its bed, as there is much erosion, and but little lateral degradation. So all of these streams cut deeper and still deeper year by year until their banks are towering cliffs of solid rock. These deep, narrow gorges are called cañons. For more than a thousand miles along its course the Colorado has cut for itself such cañons. The Rio Virgen, Kanab, Paria, Escalante, Dirty Devil, San Rafael, Price and Uinta, on the west; the Grand, Yampa, San Juan, and Little Colorado on the east—have also cut for themselves such narrow, winding gorges or deep cañons. Every river entering these has cut another cañon; every lateral creek has cut a cañon, every brook runs in a cañon; every rill born of a shower, and born again of a shower, and living only during these showers, has cut for itself a cañon; so that the whole upper portion of the basin of the Colorado is traversed by a labyrinth of these deep gorges.

About the basin are mountains; within the basin are cañon gorges; the stretches of land from cañon brink to cañon brink are of naked rock or drifting sands, with here and there lines of volcanic cones, and with black scoria and ashes scattered about. These cañon gorges and desert wastes have prevented the traveler from penetrating the country, so that, until the Colorado River Exploring Expedition was organized, it was almost unknown.

Our way for nearly fifty miles was through the Green River Bad Lands, a region of desolation. The rocks are sandstones and shales, gray and buff, red and brown, blue and black strata in many alternations, lying nearly horizontal, and almost without soil or vegetation; but they are all very soft and friable, and are strangely carved by the rains and streams. The fantastic rain-sculpture imi-

THE CAÑONS OF THE COLORADO.—THE CAÑON OF LODORE.

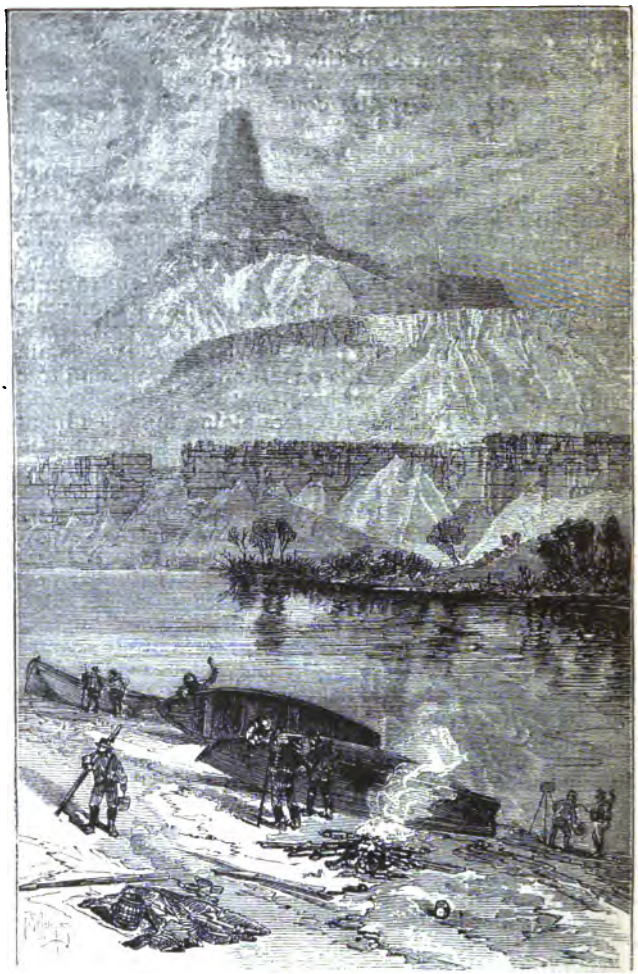
tates architectural forms, and suggests rude and weird statuary.

The general course of the Green here is to the south. The Uinta Mountains have an east and west direction, and stand directly athwart the course of the stream; yet it glides along quietly as if a mountain range were no formidable obstruction to its progress. It enters the range by a flaring, brilliant red gorge, that may be seen from the northwest a score of miles away. The great mass of the mountain ridge through which the gorge is cut is composed of bright vermilion rocks, but they are surmounted by broad bands of mottled buff and gray, and these bands come down with a gentle curve to the water's edge on the nearer slope. This is the head of the first cañon which we were to explore, an introductory one to a series made by the river through this range. We named it "Flaming Gorge." The cliffs or walls on either side we found to be about twelve hundred feet high.

You must not think of this mountain range as a line of peaks standing on a plain, but as a broad platform many miles wide, from which the mountains have been carved by the waters. You must conceive, too, that this plateau is cut by gulches and cañons in many directions, and that beautiful valleys are scattered about at various altitudes.

The cañon walls are buttressed on a grand scale, and deep alcoves are excavated; rocky crags crown the cliffs, and the river rolls below. At noon we return to camp. The sun shone in splendor on the vermilion walls, shaded into green and gray where the rocks were lichened over; the river filled the channel from wall to wall, and the cañon opened like a beautiful doorway to a region of glory. But at evening, when the sun was going down and the shadows were setting in the cañon, the vermilion gleams and roseate hues, blended with tints of green and gray, slowly changed to sombre brown above, and black shadows crept over them below. Then it seemed the shadowy portal to a region of gloom. Through this gateway we were to enter on our voyage the next day.

Entering the cañon, we found, until noon, a succession of rapids, over which our boats had to be taken by lines. Here I must explain our method of proceeding at such places. The "Emma Dean" went in advance, and the other boats followed in obedience to signals. When we approached a rapid, or what on other rivers would be called a fall, I stood on deck to examine it while the oarsmen "backed water," and we drifted on as slowly as possible. If I could see a clear chute between the rocks, away we went; but if the channel was beset entirely across, we sig-

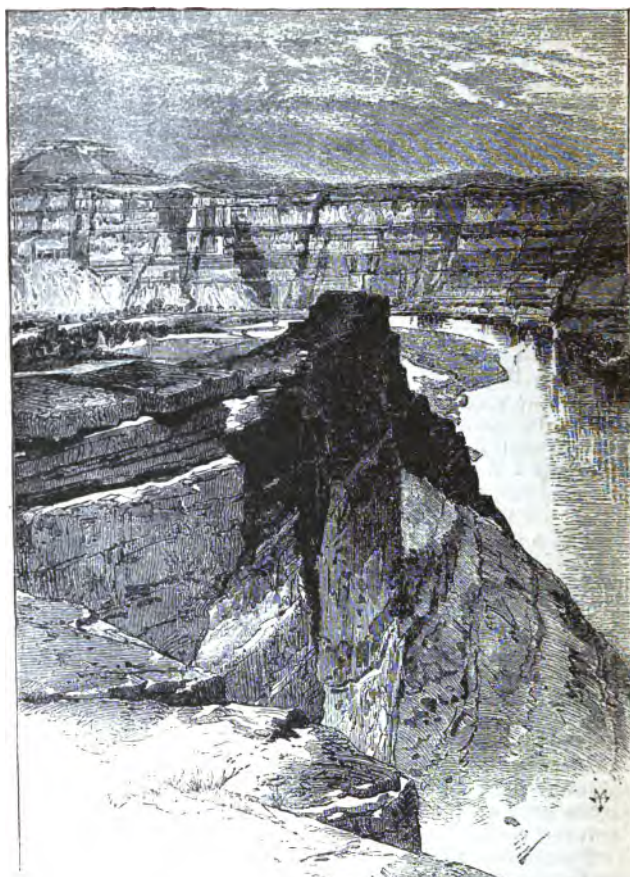


THE CAÑONS OF THE COLORADO.—NEAR ECHO PARK.

naled the other boats to pull to land, and I walked along the shore for closer examination. If this revealed no clear channel, our hard work began; we dropped the boats to the very head of the dangerous place, and let

them over by lines or made a portage; frequently carrying both cargoes and boats over the rocks, or perhaps only the cargoes, if it was safe to let the boats down. The waves caused by such a river differ much from the waves of the sea. The water of an ocean wave merely rises and falls, the form only passes on, and form chases form unceasingly. A body floating on such waves merely rises and sinks—does not progress unless impelled by the wind or some other power; but here the water of the wave passes on, while the form remains. The waters plunge down ten or twelve feet at the foot of a fall, then spring up again in a great wave, then down and up, down and up, in a series of billows that gradually disappear in the more quiet stream below. But these waves are always there, and you can stand above and count them. A boat riding such waves leaps and plunges along with great velocity. Now, the difficulty in riding over these falls, when the rocks are out of the way, is in the first wave at the foot. This will gather sometimes for a moment, heaping up higher and higher until it breaks back. If the boat strikes it the instant after it breaks, she cuts through it, and the breaker dashes its spray over the boat, and would wash us overboard did we not cling tight. If the boat, in going over the falls, chances to get caught in some side current, and is turned from its course so as to strike the wave "broadside on," and the wave breaks over us in the same instant, the boat is capsized. Still we must cling to her, for she can not sink, the water-tight compartments acting as buoys. And so we go, dragged through the waves until still water is reached. We then right the boat and climb aboard. We had several such experiences that day. And so, from day to day, we toiled on through the Cañon of Lodore.

The journey from the Gate of Lodore was marked by disasters and toils. At the junction of the Yampa and Green we found a beautiful park, inclosed on every side by towering walls of gray sandstone, smooth and vertical. There are three river entrances into this park—one down the Green, one down the Yampa, and one up the Green; there is a fourth entrance by a side cañon that comes in from the south. Elsewhere this park is unapproachable. The way through the Cañon of Lodore is a difficult and dangerous one. The course of the Yampa for forty miles above its mouth is through another cañon; it also is difficult and dangerous. Green River runs through a cañon below Echo Park, beset with rocks and interrupted by falls. So it may be said that the park has but one practicable entrance, that by a side cañon so narrow in many



THE CAÑONS OF THE COLORADO.—SUMNER'S AMPHITHEATRE.

places that a horseman could scarcely ride through it; yet we found a trail down this side cañon, and evidences that the Indians had camped in this beautiful park; in fact, it had been described to me the year before. The park itself is a beautiful natural garden, with grasses and flowering plants, shrubs and trees—just large enough for a farm.

Here we encamped for two or three days, for the purpose of repairing boats, drying rations, and to make the

observations necessary to determine the latitude and longitude of the junction of the two rivers.

The Green is greatly increased by the Yampa, and we now had a much larger river. All this volume of water, confined as it was in a narrow channel, and rushing with great velocity, was set eddying and spinning into whirlpools by projecting rocks and short curves, and the waters waltzed their way through the cañon. The cañon was much narrower than any we had seen. With difficulty we managed our boats. They spun about from side to side; we knew not where we were going, and found it impossible to keep them headed down the stream. At first this caused us great alarm, but we soon found there was but little danger, and that we really were making progress on our way.

Moving down the river, we left the valley country and entered the Cañon of Desolation. At first its waters were quiet, and the walls were low, but the cut edges of the rock were often found to be vertical, sometimes terraced, and in many places the steps of the terraces were sloping. In these great curves vast ampitheatres were formed, now in vertical rocks, now in steps. The salient of rock within the curve is usually broken down in a steep slope, and we stopped occasionally to climb out at such a place. Steadily, too, the walls increased in altitude, and, after a run of a day or two, the waters became more rapid. At last we were in a cañon with ragged, broken walls, with many lateral gulches or cañons entering on either side; the river became rough, and occasionally it was necessary to use lines in passing rocky places.

But I may not stop to tell all our adventures and mishaps—of rapids and falls, of dangerous rocks, of towering walls, and of wild, magnificent scenery. I may not describe the climb to the summit of the plateau, our hunt among the forest, or tell about the meadow-bordered lakes above. At last we left the Cañon of Desolation, and entered Gray Cañon.

Through this gorge the river was swift, and there were many rapids; when they were comparatively smooth I stood on deck, keeping careful watch ahead, and we glided along, mile after mile, plying strokes, now on the right, then on the left, just sufficient to guide our boat past the rocks into smooth water, until we emerged from the cañon below.

The plateau through which Gray Cañon is cut terminates abruptly on the south in a bold escarpment known as the Book Cliffs. The river below the cliffs runs for a time through a valley. Extensive sand-plains reach back from

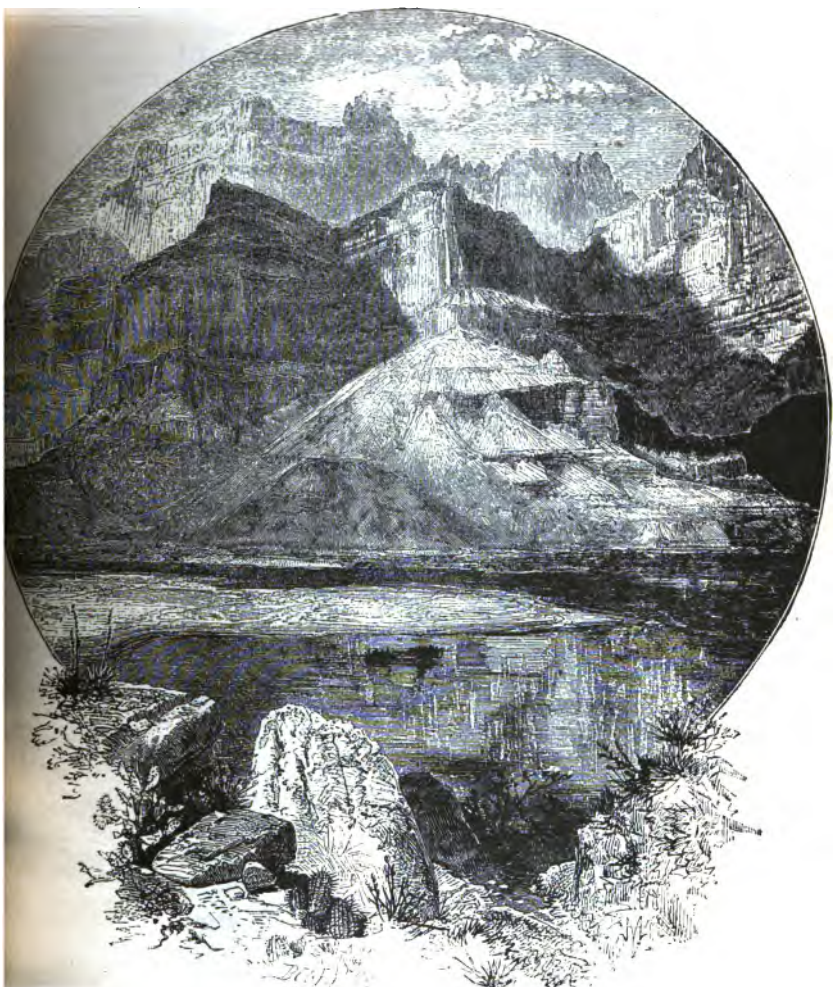
THE GRAND CHASM OF THE COLORADO.

the immediate river valley as far as we could see, on either side. These naked drifting sands gleamed brilliantly in the midday sun of July. The heat reflected from the glaring surface produced a curious motion of the atmosphere; little currents were made, and the whole seemed shifting and unstable. One moment, as we looked out over the landscape, the atmosphere seemed to be trembling and moving about, giving the impression of an unstable land; plains and hills, and cliffs, and distant mountains seemed vaguely to be floating about in a trembling, wave-rocked sea, and patches of landscape would seem to float away and be lost, and then reappear. Just opposite our camp there were buttes, composed of rock, that were outlines of cliffs to the left. Below, they were composed of shales and marls of light blue and slate colors, and above, the rocks were buff and gray, and then red. The buttes are buttressed below where the azure rocks were seen, and terraced above through the buff and gray and red beds. A long line of cliffs, or rock escarpment, separates the table-lands through which Gray Cañon is cut, from the lower plain. The eye can trace these azure beds and cliffs on either side of the river in a long line, extending across its course until they fade away in the perspective. These cliffs are many miles in length, and hundreds of feet in height, and all these buttes, great mountain masses of rock, seen through the shifting atmosphere, seem dancing and softly moving about.

On one occasion we entered a cañon with low red walls. A short distance below its head we discovered the ruins of an old building on the left wall. There is a narrow plain between the river and the wall just here, and on the brink of a rock two-hundred feet high, this old house stood. Its walls were of stone, laid in mortar with much regularity. It was probably built three stories high; the lower story was yet almost intact, the second much broken down, and scarcely anything was left of the third. Great quantities of flint chips were found on the rocks near by, and many arrow-heads, some perfect, others broken, and fragments of pottery were strewn about in great profusion. On the face of the cliff under the building, and along down the river for two or three hundred yards, there were many etchings.

The principal building is situated on the summit of the hill. Parts of the walls were standing to the height of eight or ten feet, and the mortar still remained in some places. The house was in the shape of an L, with five rooms on the ground floor; one in the angle, and two in each extension. In the space in the angle there was a

CAÑONS OF THE COLORADO.—MARBLE CAÑON.



EAD OF THE GRAND CAÑON.—JUNCTION OF THE GREAT AND LITTLE COLORADO RIVERS.

MONUMENT IN GLEN CAÑON.

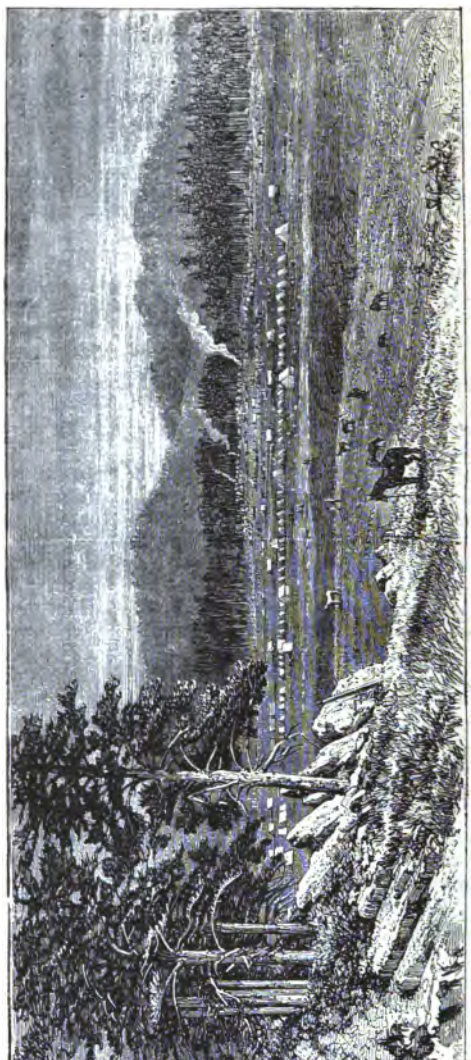
deep excavation. From what we knew of the people in the province of Tusayan, who are doubtless of the same race as the former inhabitants of these ruins, we concluded that this was a "Kiva" or underground chamber, in which their religious ceremonies were performed.

The sandstone through which this cañon is cut, is red and homogeneous, being the same as that through which Labyrinth Cañon runs. The smooth naked rock stretches out on either side of the river for many miles, but curiously-carved mounds and cones are scattered everywhere, and deep holes are worn out.

I attempted to climb a rounded eminence, from which I hoped to obtain a good look-out over the surrounding country. It was formed of smooth mounds piled one above another, and up these I climbed, winding here and there to find a practicable way, until near the summit, when they became too steep for me to proceed. I searched about for a few minutes for a more easy way; what was my surprise at finding a stairway, evidently cut in the rock by human hands! At one place, where there is a vertical wall ten or twelve feet high, I found an old rickety ladder. It may be that this was a watch-tower of that ancient people whose homes we had found in ruins. On many of the tributaries of the Colorado I had before examined their deserted dwellings. Those that showed evidences of being built during the latter part of their occupation of the country, were usually placed on the most inaccessible cliffs. Sometimes the mouths of caves had been walled across, and there were many other evidences showing their anxiety to secure defensible positions.

Probably the nomadic tribes were sweeping down upon them, and they resorted to these cliffs and cañons for safety. It is not unreasonable to suppose that this orange-mound was used as a watch-tower.

I stood where a lost people had lived centuries ago, and looked over the same strange country. I gazed off to great mountains in the northwest, slowly covered by the night until they were lost, and then turned toward camp.



THE NEW GOLD REGIONS—BLACK HILLS.

GEOLOGY AND MINERALOGY.

DISCOVERY OF NEW GOLD FIELDS.

No expedition since the war has attracted more attention or excited more interest than the one which left Fort Abraham Lincoln, Dakota, on the 2d of July, 1874, to explore the Black Hills. This region of country, lying in the southwestern part of Dakota, and extending some distance into Wyoming, and slightly indenting Montana, has, until now, in its interior been entirely unexplored by the white man. Previous expeditions have skirted the hills, but never penetrated them, and we have been dependent on the reports and traditions of the Indians for the little we have known of them. The hostility of the Indians has defeated any attempts to explore the country by civilian parties.

The present expedition was entirely a military one, and consisted of ten companies of the Seventh cavalry, two companies of infantry, and three pieces of artillery, in all about 700 soldiers, with the addition of a train of 120 wagons, and about as many teamsters, the whole under command of Major-General George A. Custer. The scientific corps consisted of Colonel William Ludlow, U. S. Engineer Corps; W. H. Wood, assistant; Professor N. H. Winchell, geologist; Professor A. B. Donaldson, assistant; George B. Grinnell, paleontologist; L. H. North, assistant; Dr. J. W. Williams, chief medical officer, botanist.

The expedition reached the Black Hills about the 20th of July, after a march of eighteen days, mostly over an arid, treeless, desert country. General Custer, in spite of the prophecies of his Indian guides, who declared the thing impossible, succeeded in penetrating to the very interior of the hills with his wagon train, and by sending off detachments of cavalry here and there, has succeeded in exploring and mapping the hills through their entire length and breadth. The country is found to be of great scenic beauty, as shown by our illustration, and is luxuriant in vegetation, abundant in game, timber, and good water. Thousands of acres of fertile land invite settlement. The country, however, is a part of the Sioux reservation, and can not be opened to the whites until the government shall make some satisfactory arrangement with the Indians.

On the 31st of July gold was discovered along the banks of a creek on which the expedition was encamped, the

best pans yielding from five to ten cents' worth of gold, equivalent to fifty dollars a day to the man, if the yield should prove as good as promised.

Our camp view of the principal park in the hills gives some idea of the size of the expedition. This site was selected for the permanent camp, and from this point detachments radiated for several days.

BERYLS AND EMERALDS.

ALTHOUGH to the mineralogist the stones known as aquamarine, beryl, and emerald, constitute, says Prof. A. H. Church, but one species, there are decided differences of optical properties, as well as minute differences of chemical composition, between them. Under the name "beryl" minerals of considerable variety of aspect are thus included; some specimens being nearly opaque and brownish-yellow, others being perfectly transparent and colorless, while others, again, are beautifully tinted with a pale sea-green hue. But other colors also occur, such as yellowish-green, pale blue, and even lilac. Still it is in the emerald, once thought to be a distinct mineral species, that the richest and most highly appreciated color is found. The pure green of this gem has provoked several inquiries as to its nature.

This mineral species occurs only in crystals, while such divergences from constancy of composition as it exhibits, affect scarcely more than two parts out of 100 in any specimen. It is essentially a silicate of alumina and glucina, but it always contains a little iron, while chromium seems a constant ingredient of the true emerald, though occurring as a trace merely, not amounting to a half per cent when calculated as sesquioxide. Other metals have been recognized in some varieties of the beryl by different analysts, and the list will include calcium, magnesium, manganese, and tantalum.

The specific gravity of transparent pale beryls is, as nearly as may be, 2.7, so that it is decidedly denser than rock crystal. The same is true of the emerald when perfect, but the general presence of internal flaws in this stone, even though they may be very minute, lowers its specific gravity decidedly, and may even reduce it to that of rock crystal.

Pure, transparent, and colorless or pale specimens are harder than quartz, varying from 7.5 to nearly 8; yet the best emeralds—though they scratch quartz, and, of course, all kinds of glass and paste as well—are slightly softer than the paler varieties of the species, such as the aquamarine.

The question of the color of the emerald has lately been studied with particular care by Mr. Greville Williams. The green hue of this gem is of a different quality from that of the precious beryl and the aquamarine, indeed, it closely approaches, in really good specimens, to the pure green of the solar spectrum. The color is, also, far more permanent than that of some beryls, especially those of a yellow or greenish-yellow hue, which become bluish, or even pale blue, when heated before an ordinary gas blowpipe jet, long before they show any signs of incipient fusion. The emerald, on the other hand, when heated alone before the oxyhydrogen blowpipe, bears a bright red heat without loss of color, and even when it begins to fuse the edges only become colorless and opaque, the centre remaining green. Even when fused, emeralds are kept at the maximum temperature attainable by means of the oxyhydrogen blowpipe, they retain an opalescent dull green hue for some time, and it is only after prolonged heating that they become at last transparent, and almost free from color. Artificial beryl-glasses are made by taking the essential constituents of the mineral in the percentage proportions here given:

Silica	67.5
Alumina	18.5
Glucina	14.0
	100.0

By the fusion of these ingredients together, a beryl-glass is obtained which is practically identical in physical and chemical characters with that resulting from the fusion of the native emerald or beryl. In each case the hardness is reduced below 7 (that of quartz), and the specific gravity is only 2.42, instead of 2.7. These are signs that the compound has passed into the vitreous condition, and that it is destitute of crystalline structure. Though really identical in chemical composition with the native beryl, these beads are nothing more than "beryl-glasses," and can never in such a condition compete with the true native stones. Even were the exact tint of color to be achieved, and if the hardness and specific gravity of the artificial glasses were much increased, still there would remain one fatal inferiority to the true emerald. For an emerald is dichroic, exhibiting, when viewed along the principal axis of the crystal, a green hue decidedly dashed with yellow, while, when viewed in any direction transverse to this, it shows a green color verging a little towards blue.

One of the main objects for which Greville Williams' research was undertaken, was the settlement of the relation between the so-called organic matter found in the

emerald and the color of the stone. By an ingenious arrangement of apparatus, and by the use of the chromic acid method of burning the carbon and hydrogen present, this chemist has shown that colorless beryls sometimes contain carbon and hydrogen, just as the emerald does; and he has demonstrated that the carbon does not exist as a carbonate, though it may possibly occur in the form of microscopic diamonds. We are promised a further contribution to the chemistry of the emerald, with especial reference to the modes of separating and estimating the rare earth, glucina, which it—in common with the chrysoberyl, another mineral used in ornamental jewelry—also contains. The chemist Lœwy, who believed the color of the emerald to be due to organic matter, detected the earth glucina, to the extent of ½ per cent, in the calcareous concretions which are associated with the matrix in which the mineral is found at Muzo, New Granada: pyrites, and the rare carbonate of the cerium metals known as Parasite, also occur with the emerald.

The emerald is more prized now than formerly, as much as $200 having been given for a perfect emerald of 1 karat (0.245,41 of a gramme, or 3.17 grains). An emerald of 1 karat, owing to its low specific gravity, is of course much larger than a sapphire of the same weight, and about one-third larger than a diamond. Large emeralds are seldom of uniform and deep color, and hardly ever free from numerous cavities and flaws. In the Duke of Devonshire's collection there is a splendid crystal, about 2 inches in each direction, and weighing nearly 9 ounces troy, but it is much flawed. In the Green Vaults of Dresden there are some fine stones, while there are also numerous specimens in the Brazilian, Turkish, Portuguese, Austrian, Persian, and Papal treasuries. Many of these have, however, been disfigured by perforations or inartistic engravings, and being in many cases merely rounded and polished, "*en cabochon*," are not capable of showing to full advantage those optical properties of dispersion, refraction, dichroism, etc., which may be developed by the judicious cutting of this gem. The true emerald is not well adapted for the purposes of the cameo and intaglio cutter, and was seldom engraved in Europe, although some examples exist. But the transparent beryl, and particularly the aquamarine, have frequently been engraved with great skill and beautiful effect, both in classic and later times. Several good specimens of this kind are preserved in different public and private collections of gems, both in England and on the Continent. In the Bibliothèque Nationale of Paris there is a fine cameo of Julia, the daughter of Titus.

Some perfectly transparent and flawless aquamarines have been found of enormous size. One Brazilian stone weighs 225 troy ounces, and is as big as the head of a calf! The writer of this notice has seen one in London, of a rough spherical form, of perfect purity, though pale in tint, and nearly 4 inches in diameter. Mr. Hope possesses, in the hilt of Murat's sword, an aquamarine of remarkable size: there is also a fine, richly-colored stone among the Crown jewels in the Tower of London.

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THE GLACIAL LAKE PERIOD.

THE theory of the blocking up by ice of the drainage of countries in the glacial period, and the formation of large and small lakes, will, according to T. Belt, explain the existence of many stratified deposits that are supposed to prove the great submergence of the land below the waters of the ocean. Thus, if the ice once filled the beds of the German Ocean and the Irish Sea, all our rivers running to the west and to the east must have at one time been dammed back by it. Similarly, every lateral valley in the north of England and in Scotland was at one time or another occupied by a glacial lake; and thus, I believe, says the author, the stratified sands, often false-bedded, that lie above the boulder-clay, were formed. In many cases the barrier ice seems to have been suddenly removed or broken through, and the escaping rush of water has cut down through the sands and left them in long ridges or isolated mounds.

Again, the ice that descended from the mountains of Scandinavia must have dammed back all the rivers of Northern Europe; and I think that a great part of Central Europe must at that time have been occupied by great fresh-water lakes over which floated icebergs.

DISCOVERY OF INTERESTING FOSSILS.

PROF. O. C. MARSH, of Yale College, recently made an important and somewhat dangerous expedition in the "Bad Lands," south of the Black Hills, in Dakota Territory. The opposition of the Indians, who were collected in great numbers at the Red Cloud Agency, the point of departure of the expedition, and the intense cold, were not sufficient to cool the enthusiasm of Professor Marsh in his great bone hunt, and the results obtained were very gratifying. The following is a brief description of these interesting discoveries:

The bones obtained are those of tropical animals, of the miocene era. There are nearly two tons of these fossils; most of them are rare specimens, illustrative of entire

classes of quadrupeds, of which all that is known has been ascertained within a very few years; some of the bones are those of animals entirely new to science. The brontotherium is one of the larger quadrupeds whose remains are entombed in the bed of this miocene lake. It was as large as an elephant, and bore a general resemblance of form to that animal, but differed in many essential particulars. Its shorter limbs were like those of the rhinoceros; its nose was adorned with a pair of huge horns, placed crosswise. Its skull is a yard in length. It had no tusks, or long proboscis, such as the elephant possesses; but its nose was probably elongated and flexible, like the snout of a tapir. In fact, its head and neck were so long that it had no need of an elephantine proboscis. These animals must have lived together in herds. Probably their remains were washed into the lake by a freshet, and thus were buried in the mud with which the lake was finally filled, which has now hardened into stone. Among other remains found are those of animals nearly allied to the rhinoceros, the camel and the horse of to-day. The stratum in which the fossils lay was of the lowest miocene, and could only have been reached by the upper miocene, and the pliocene above that having been washed away by a water-course in this gully. Hence the locality of the deposits was narrow, and the expedition was able to get at and remove them entirely. A careful examination of the surrounding region showed that nowhere else had any watercourse cut deep enough to lay bare this stratum.

Aside from the novel points obtained concerning specific fossils, the expedition has made an important determination respecting the geology of the region. The fact was ascertained that the miocene lake was of more limited extent than has hitherto been asserted, although larger than all the great lakes of the Northwest at the present day would be if combined in one. Its northern limit was the southern slope of the Black Hills; its western margin the Rocky Mountains; its southern limit near the northern line of Kansas. Long after this lake was filled and dried, another tropical lake covered the same region, having the same boundaries at the north and west, but extending southward even to Texas. The sands and clay deposits of this more recent lake basin are of the pliocene age; they are of great thickness, in some places not less than 1,500 feet. No inconsiderable part of the beds which Professor Hayden has regarded as belonging to the miocene or lower lake formation proves to be of the pliocene or upper lake, the miocene being only visible in occasional depressions where the pliocene has been

washed away. All, or nearly all, the high table lands from the White River to Arkansas are formed of the deposits of the pliocene lake; it has proved rich in organic remains, especially in fossil horses; but all the animals found in it differ from those of the lake below, as well as from those now living. Many obscure and some contested points in science will be determined by the material which Professor Marsh's expedition of 1874 has gathered. (25)

GLACIAL PHENOMENA IN THE SIERRA NEVADA.

PROF. JOHN MUIR has studied that portion of the Sierra which is embraced between latitude 36° 30′ and 39°, which measures about 200 miles in length by about 60 in width, and attains an elevation along the axis from 8,600 to nearly 15,000 feet above the sea. All the individual mountains distributed over this vast area, of whatever kind, have been brought into relief during the glacial epoch by the direct mechanical action of the ice-sheet and the glaciers into which it afterwards separated. The chief phenomena are (1) scratched and polished surfaces, (2) moraines, (3) moutonned rock-forms, and sculpture in general, as seen in valleys, ridges, lake basins, and separate mountains.

The polished surfaces occur in the summit and upper half of the middle region in irregular patches, some of which are several acres in extent, and though they have been subjected to corroding influences for thousands of years, their mechanical condition is such that they still reflect the sunbeams like glass. The lowest patches occur at elevations of from 3,500 to 5,000 feet above the sea-level, and 30 to 40 miles below the summits, upon the dryest and most enduring portions of vertical walls, where they are protected from the drip and friction of water; also on hard-swelling bosses on the bottoms of valleys, where they are kept dry by boulders.

In the summit regions, small, active glaciers still linger, which present moraines of every kind in process of formation. All of the magnificent forests of the Sierra, Professor Muir thinks are now growing upon moraine soil, which as yet has suffered little change since it was first eroded and outspread for them by the ancient glaciers. The most imperishable of the glacial phenomena under consideration are the valleys, ridges, and rock masses, the trends, shapes and geographical position of which are specifically glacial; yet even these are considerably obscured by post-glacial weathering and a growth of forests. The glacial phenomena, therefore, become more legible as one ascends to the fresh work of the active glaciers on the summits.

The author glances at the post-glacial changes, caused by earthquakes, traces of which are still conspicuous in every sheer walled valley and around the bases of the summit peaks. The post-glacial streams of the Sierra are all young, and have not flowed long enough over the brilliantly polished bottoms of the glacier valleys to make definite beds. Atmospheric weathering has done more to blur and degrade the glacial features of the Sierra than all other agents combined.

ICE OF THE GLACIAL PERIOD NOW WITHIN THE ROCKY MOUNTAINS.

R. WEISER, of Colorado, states that there is a silver mine high on McClellan Mountain, called the "Stevens Mine," altitude 12,500 feet. At the depth of from 60 to 200 feet the crevice matter, consisting of silica, calcite, and ore, together with the surrounding wall-rocks, is found to be in a solid frozen mass. A tunnel is driven into the mountain on the lode, where the rock is almost perpendicular. Nothing unusual occurred until a distance of some 80 or 90 feet was made; and then the frozen territory was reached, and it has continued for over two hundred feet. There are no indications of a thaw, summer or winter; the whole frozen territory is surrounded by hard massive rock, and the lode itself is as hard and solid as the rock. The miners being unable to excavate the frozen material by pick or drill to get out the ore (for it is a rich lode, running argentiferous galena from 5 to 1,200 ounces to the ton), found the only way was to kindle a large wood fire at night against the back end of the tunnel and thus thaw the frozen material, and in the morning take out the disintegrated ore. This has been the mode of mining for more than two years. The tunnel is over 200 feet deep and there is no diminution of the frost; it seems to be rather increasing. There is, so far as we can see, no opening or channel through which the frost could possibly have reached such a depth from the surface. There are other mines in the same vicinity in a like frozen state.

From what we know of the depth to which frost usually penetrates into the earth, it does not appear probable that it could have reached the depth of two hundred feet through the solid rock in the Stevens Mine, nor even through the crevice matter of the lode, which, as we have stated, is as hard as the rock itself. The idea, then, of the frost reaching such a depth from the outside, being utterly untenable, I can do no other way than to fall back upon the Glacial era of the Quaternary. Evidences of the glacial period are found all over the Rocky Mountains. Just above the Stevens Mine there are the remains of a moraine

nearly a mile long and half a mile wide. The debris of this moraine consists of small square and angular stones, clearly showing that they have not come from any great distance. And just over the range, on the Pacific slope, there are the remains of the largest moraine I have ever seen, consisting of feldspathic boulders of immense size. I conclude, therefore, that it was during that period of intense cold that the frost penetrated so far down into these rocks; and that it has been there ever since, and bids fair to remain for a long time to come. (7)

THE MAMMOTH CAVE OF MEXICO.

IT is said that the cave of Cacahuamilpa is the largest cave in the world. Several persons, who have visited the Mammoth Cave of Kentucky and that of Cacahuamilpa in Mexico, pronounce the latter the larger. A volcanic mountain with an extinct crater covers this cave. It is not described in guide-books or books of travel. It has, in fact, never been adequately described. Mr. Porter C. Bliss has twice examined and explored it, the last time in February of the present year. Six hundred persons constituted the last exploring party; they were provided with Bengal lights and scientific appliances. After reaching a level at perhaps 50 feet depth, they proceeded 3¾ miles into the interior. The roof was so high—a succession of halts —that rockets often exploded before striking it. Labyrinthine passages leave the main hall in every direction. Stalagmites and stalactites are abundant. Below this cave, at a great depth, are two other immense caves, from each of which issues a branch of a great river, uniting here. These two rivers enter some five miles distant at the other side of the mountain, flow parallel, and issue at last together. Vast quantities of bats are the most numerous inhabitants of these caverns.

A HILL OF SULPHUR.

ONE of the most remarkable deposits of native sulphur, as yet discovered, is a great hill composed of the almost pure article, found some two years ago at a distance of thirty miles south of the Union Pacific Railway and nine hundred miles west of Omaha. This marvelous deposit is found to consist almost wholly of sulphur, containing only 15 per cent of impurities. The best deposits heretofore available are those found in Sicily. The principal supplies for the manufacture of sulphuric acid come from there; the deposits contain 35 per cent of impurities and 65 per cent of sulphur. Our western sulphur hill, therefore, is much the most valuable, and promises to become ere long of great importance to the country. (83)

HEREDITARY MOLECULES.

BY PROF. LEWIS ELSBERG.—The impregnated ovum, which matures as an animal, consisted of matter wholly derived from the bodies of its parents; in the same manner the germs from which each of these parents has sprung, existed in the bodies of their parents. And as the child's whole body has grown from the germ originally derived from the bodies of its parents, it is certainly not unreasonable to assume that whatever the child of either sex, later in life, contributes to the formation of a new being, contains a few of the identical material particles which constituted the germ from which it arose; in other words, that the germ of this new being contains a few plastidules of its grandparents. To those who can more readily conceive the idea of force being transmitted than matter, it may make the subject clearer to state that I regard a "plastidule" quite as much as a centre or bundle of force as of matter.

Nor is the specific transmission of the identical plastidule the point necessarily insisted upon, since the transmission of particles rendered identical by assimilation and growth meets the purposes of the argument. Nevertheless, actual material transmission appears to me the most probable.

With this assumption the fact of the resemblances in features of children to grandparents, other inheritances, good and evil, predisposition to disease, reversion, etc., are quite naturally explained. The assumption made, and we will not find it difficult to believe that the germ of a child contains molecules or plastidules, or bundles of force, derived through its parents from grandparents, great-grandparents, and, in fact, from a long line of ancestry. The difference, then, between the germs of the different persons, not recognizable by chemical reaction or microscopical inspection, but ascertained by another mode of analysis, viz., logical reasoning, is an evolutional one, and consists in the fact that each contains the molecules of its own line of ancestry.

The hypothesis of the propagation of organisms may be stated as follows: The germ of every derivative living being contains plastidules of its whole ancestry. Now plastidules, although exceedingly small, are real magnitudes, like molecules in contradistinction to atoms. The plastid-molecule or plastidule has actual dimensions; and the statement of the assumption that a germ contains plastidules of the whole line of ancestral organisms, needs, therefore, the qualification that, after a certain vast number of generations, the beginning of the line must become

cut off by the exhaustion of the plastidules of the most distant ancestor. This accounts for what has been called the law of abbreviated heredity.

In the beginning there existed no living beings upon this planet. All living beings have been originally produced by conversion of inorganic matter first into the simplest organic being, protoplasson. This "special creation" has been many times repeated since the beginning, and is still going on; and so has evolution, which is regeneration according to the laws of adaptation and heredity, been going on from the beginning, and is still going on. The protoplasson which started on its evolution first in time, is, other circumstances being equal, most highly developed, which means that it may be stated as generally true that the most highly developed organisms are so simply because they are the oldest in organic existences; those in their constitution nearest protaplasson are the youngest. The difference of rank among existing forms is mainly due to the difference of time during which, or the number of times which, regeneration has occurred; the difference of direction in which development has taken place is due to the modifying or adapting influences with which the organism has been surrounded. The fossil fish of the silurian age is not the ancestor of any fish now living; if any of its progeny has survived, it belongs now to a different class of vertebrates than fish; the fish of to-day comes from protoplasson which has originated later in time than that from which the silurian fish sprang. Man has not been most recently created, but earliest. We are really the descendants, or the ascendants, of the oldest inhabitants of our globe. (144)

STRUCTURE OF COAL.

By close investigation, E. W. Binney, F.R.S. believes that he has established the following facts: Soft caking, or cherry, coal is chiefly composed of the bark, cellular tissue, and vascular cylinders of coal plants, with some macrospores and microspores. Caking coal has much the same composition, except that it contains a greater proportion of bark. Splint, or hard coal, has a nearly similar composition, but with a great excess of macrospores. Cannel coal, especially that yielding a brown streak, is formed of the remains of different portions of plants which had been long macerated in water; it contains a great excess of microspores. Macrospores are from $\frac{1}{300}$ to $\frac{1}{75}$ of an inch in diameter, and can be easily seen by the naked eye. Their exterior is composed of a brown coriaceous substance, containing within it carbonate of lime or bisul-

phide of iron, according to the nature of the matrix. The microspores are about 320 times less in size, and contain some form of hydrocarbon, which, by the action of heat, becomes paraffin. These conclusions were arrived at merely as to the composition of the different kinds of coal. Each seam is materially affected by the nature of the roof, since, if it is an open sandstone, gaseous matter can freely escape, which is, of course, not the case when the seam is roofed in with airtight black shale or blue bind.

GEOLOGICAL MAP OF THE UNITED STATES.

THIS map, the authors, Professor C. H. Hitçhcock and William P. Blake, state, was published in connection with the report of the ninth census. It was compiled from all existing State reports and maps, furnished privately to the authors. Professor Blake was responsible for the extreme western portion. The map is therefore the joint product of all American geologists. Several features suggest themselves on examining the map.

First. The great contrast between the East and West: the former containing the beds of coal and limestone is, therefore, the manufacturing region; the latter, containing the ores without the fuel, is the great mining and, to some extent, agricultural region.

Second. The broad layer of superficial formations on the east coast, disappearing north of Long Island, indicates the presence of a belt of low, flat country.

Third. The arrangement of formations along the Mississippi River illustrates the gradual reclamation of the Mississippi Valley from the Gulf of Mexico.

Fourth. The volcanic rocks are confined to the western portion. This fact, although well known to Americans, is unknown in Europe; whence we can understand the criticism of a British geologist, that the map was faulty because no volcanic rocks were represented in the east.

Fifth. The marked feature consists in a broad expanse of cretaceous and tertiary formations along the prairies between the Mississippi River and the Rocky Mountains.

Sixth. The higher Rocky Mountain chain seems to be exclusively eozoic. Several corrections of the map in the new edition about to be published, in connection with the supplementary volume of the ninth census, were alluded to by Professor Hitchcock. First, an extensive area of eozoic and Cambrian formations in North Carolina, to the exclusion of a portion of the cenozoic. Second, the supposed Huronian of the elevated plateau in Dakota is now referred to the Cambrian extending to Lake Superior on

the one hand and northeasterly into British America on the other, upon both sides of a promontory of eozoic agreeing with the Baraboo quartzites of Wisconsin. Third, a broad expanse of cretaceous is now represented for the first time in North and South Carolina. Fourth, the cretaceous of Minnesota is largely omitted, in order to show the underlying granites.

THE GREAT LAVA FLOOD OF OREGON.

PROF. JOSEPH LE CONTE, of the University of California, states that probably the most extraordinary lava flood that has ever occurred once covered the greater portion of Northern California and Northwestern Nevada, nearly the whole of Oregon, Washington, and Idaho, and ran far into Montana on the east, and British Columbia on the north. Derived from streams originating in fissures in the Coast, Cascade and Blue ranges, it covered an area of 300,000 square miles to an average thickness of 2,000 feet. The whole Cascade range is composed of lava, tier upon tier, from top to bottom, forming a depth in some places of 4,000 feet. The order of events which occurred in the region of the Columbia River is graphically depicted, and the writer gives with considerable detail the natural phenomena which lead him to the conclusion that the locality was a forest, probably a valley overgrown with conifers and oaks. The subsoil of this forest was a coarse boulder or drift. By excess of water, either by flood or changes of level, the trees were in time killed, their leaves shed and buried in the mud, and their trunks rotted to stumps. Then a tumultuous and rapid deposit of coarse drift, containing driftwood, covered up the forest ground and the still remaining stumps to the depth of perhaps several hundred feet, the surface thus formed eventually becoming eroded into hills and dales. Over a long period following came the outbursts of lava in successive flowers, with the silicification of the wood, and the cementation of the drift by the percolation of hot alkaline waters containing silica, as happens so commonly in sub-lava drifts. Finally succeeded the process of erosion by which the present stream channels, whether main or tributary, have been cut to their enormous depth.

In referring to the age of the Cascade range, Professor Le Conte concludes that it was first born of the sea, by horizontal washing and vertical swelling, probably at the end of the jurassic, though only as a low range, continuing the sierra northward; its subsequent increase took place at the end of the miocene, by the outpouring of the great lava flood above described.

JAMES LICK.—FOUNDER OF THE SIERRA NEVADA ASTRONOMICAL OBSERVATORY.

(See Biography.)

ASTRONOMY.

THE ZODIACAL LIGHT.

THE zodiacal light is a faint nebulous radiance, which, at certain seasons of the year, and especially within the tropics, is seen at the west after twilight is ended, or in the east before it has begun. The luminosity is conical in shape, the breadth of the base varying from 8° to 30° in angular magnitude, and the apex being sometimes more than 90° in rear of or in advance of the sun. To account for this appearance, several theories have been advanced. Cassini believed it a lenticular solar emanation; Kepler considered it the sun's atmosphere, and Maeran, a reflection from the latter stretched out into a flattened spheroid. Laplace declared the phenomenon to be a nebulous, rotating ring, situated somewhere between the orbits of Venus and Mercury; and Chaplain Jones, U.S.N., whose examinations into the subject have been the most extensive on record, also believed it a nebulous ring, but continuous, and not located, as stated by Laplace. Professor Wright's deductions, as will be seen, fail to agree exactly with any of these views.

But few attempts, it appears, have ever been made to determine whether or not any portion of the light is polarized, and up to the present time, knowledge on the subject has been uncertain and contradictory, pointing either to the idea that the rays are not polarized at all, or that the proportion of polarized light is so small as to render it nearly impossible to be detected. Professor Arthur W. Wright, of Yale College, becoming convinced that the difficulty should be ascribed to the imperfections of the instruments employed, constructed a new polariscope of extraordinary sensibility, and the first favorable opportunity to test its powers on the zodiacal light was improved. It was almost immediately found to indicate the existence of light polarized in a plane passing through the sun; and in no instance, when the sky was clear enough to render the bands visible, did their position, as determined by the observation, fail to agree with what would be required by polarization in the plane above noted. The polarization, it was also proved, did not arise from faint vestiges of twilight, the reflection of the zodiacal light itself in the atmosphere, or from impurities in the latter.

Further experimenting was at once proceeded with to

determine the percentage of light polarized, and it gave, as the means of numerous determinations, the angle 36.6°, corresponding to a proportion of 16 per cent; 15 per cent Professor Wright thinks may be safely taken as the true value.

The fact of polarization implies that the light is reflected, either wholly or in part, and is thus derived originally from the sun. No bright lines were found in the spectrum, nor could any connection be traced between the zodiacal light and the polar aurora. This is important, as excluding from the possible causes of the light the luminosity of gaseous matter, either spontaneous or due to electrical discharge. Hence, Professor Wright concludes that the zodiacal light is reflected from matter in the solid state, from innumerable small bodies revolving about the sun in orbits, of which more lie in the neighborhood of the ecliptic than near any other plane passing through the sun. These meteorites, which are in all probability similar in character to those which fall upon the earth, must be either metallic bodies or stony masses.

The spectrum is the same as that of sunlight, except in intensity.

THE SOLAR ECLIPSE OF 1874.

A TOTAL eclipse of the sun was observed by Mr. Stone, English astronomer Royal at the Cape of Good Hope, on the 16th of April last. The line of totality passed over the southern extremity of Africa, beginning at Port Nolloth on the west coast of Cape Colony, somewhere about 250 miles from Cape Town, and took a curved path, with the convexity turned toward the north, ending at sunset about half way across.

The day was especially favorable for observation, and the sky was entirely free from clouds. Mr. Stone states that the rose-colored flames extended very nearly around the moon, although, of course, of unequal heights, at different parts. The spectrum near the moon's limb was carefully examined in order to discover fresh lines, but none appeared, and hence there can not be any medium capable of producing sensible absorption of light around the moon.

At the instant of totality the whole field appeared full of bright lines, all the principal Fraunhofer lines being reversed. Mr. Stone's observations tend to confirm those of the eclipses of 1869, 1870, and 1871, and their most important portion is that referring to the visibility of the Fraunhofer lines in the spectrum of the coronal atmosphere, showing thereby that that reflects the light of the photosphere.

COLLIMATOR AND PERSONAL EQUATION MACHINE.

BY WILLIAM A. ROGERS.—If a lens of short focus be inserted in one end of an open tube, the light passing through the opening at the other end is diminished in size in proportion to the distance of the aperture from the condensing lens. For example, if the focus of the lens is one-fourth of an inch, and the distance of the aperture at the other end of the tube is 12 inches, the image will be diminished 48 times. In this way artificial stars of various magnitudes may be formed, and these points of light may be made to serve the purpose of a collimator with great ease and facility.

With the artificial star thus formed, and revolving with uniform motion on a disc, both the absolute and the relative personal equation can be obtained within two or three hundredths of a second. Personal equation was defined to be the time by which an observer anticipates or delays his record of a transit over the meridian. The machine exhibited aimed to answer the following requirements: (1.) That the artificial star must as nearly as possible resemble a star in the heavens, whether observed in the day-time or night. (2.) That the motion of the artificial star must correspond with the variable motion in diurnal arc, being most rapid at the equator and zero at the pole. (3.) That the artificial star must be adjustable in magnitude. (4.) That the apparatus should be such that the observation of the artificial star may be made with the same instrument with which the actual observations are made. (144)

THE GLIMMERING OF VENUS.

THE fact that occasionally the dark half of the surface of the planet Venus glimmers with a peculiar gray light is one of the most interesting phenomena that are recorded in connection with the planets of our system. The records of the numerous cases in which this phenomenon has been observed have been collated by Dr. Safarik. Among the various and sometimes fanciful theories that have been devised to explain this phenomenon, that which seems most likely to be the true one is the possibility that the illumination of the dark half of Venus is effected by means of the light reflected from a satellite to that planet. This theory he has, indeed, especially developed in his work on descriptive astronomy, in which he also explains why the secondary illumination of Venus is so seldom visible in the great telescopes, and why the question whether Venus possesses a moon must still remain an open one.

TELESCOPIC VIEW OF THE MOON.

A TELESCOPIC VIEW OF THE MOON.

To those who have never gazed upon the surface of our satellite through a telescope the annexed illustration will be of interest, since it gives an admirable representation of the appearance of the moon at a period between new moon and first quarter. The picture, made from a lunar photograph, is itself remarkable as a work of art, showing the perfection with which the wood-engraver can imitate the delicate shades painted by the action of light. The various physical characteristics of the lunar surface can be excellently distinguished. The large patches of dark shade near the lower portion of the picture are commonly called seas, though they undoubtedly contain no water. The bright white spots are great table-lands and mountain chains, some of which extend over enormous areas of the moon's surface. These indicate the action of tremendous forces of upheaval. There are, besides, isolated mountains and peaks, indicated by single luminous dots, which, rising from plains nearly level, spring to perpendicular altitudes of four and five miles.

The crater mountains are the principal feature of the moon's topography. These, a large number of which appear on the upper portion of the illustration, are divided into walled plains which vary in diameter from 120 to 150 miles—ring mountains, the diameter of which descends to 10 miles, and craters still smaller. The depth of these peculiar formations ranges from one-third of a mile to three miles and a half. They are often surrounded by annular ridges, and from the centre a conical peak generally rises. The larger ones are probably of volcanic origin, and the smaller pits are by some ascribed to the impact of meteors with the moon, while the surface of the latter was yet plastic. Clefts are often met with, due to cracks in the shrinking surface and innumerable small ranges of hills, running in between and inclosing the craters in a great network.

The process of lunar photography, to which we are indebted for so much of our selenographical knowledge, was first practised by Dr. W. H. Draper, of this city, in 1840, and subsequently in France by M. De La Rue. The best photographs made during late years are those of Dr. Henry Draper and Mr. L. M. Rutherford, both of New-York. The latter astronomer uses a telescope of 13 inches objective, in which suitable arrangements are provided whereby the lens is corrected for yellow rays, and the image of the moon is brought in the primary focus of the instrument. The time of exposure of the plate is about half a

second. The negative obtained is subsequently slightly enlarged in a camera provided with an achromatic condenser, into which the light is thrown by a heliostat.

SIRIUS.

AT a recent meeting of the Royal Astronomical Society, a paper on Sirius, by Mr. J. M. Wilson, was read. His observations tended to confirm the speculations of spectroscopists that Sirius is intrinsically much brighter than the sun, and must, therefore, be of a higher temperature. His measures of the position of the companion of Sirius showed that it is now passing away from its periasteon, and that the time of a complete orbital revolution is probably nearly two hundred years. Taking the parallax of Sirius as 0.22", the distance of the companion from the principal star is about fifty times the earth's distance from the sun. This would give the mass of Sirius as only $3\frac{1}{8}$ times the mass of the sun, while the amount of its light is estimated at more than two hundred times the light of the sun. He therefore concluded that, area for area, Sirius must be much more intensely luminous than the sun. He wished to direct attention to the companion of Sirius, and to point out that it is within the reach of instruments of only moderate aperture. The telescope with which his observations have been made is a refractor of $8\frac{1}{4}$ inches. He has ordinarily used a power of 400.

Mr. Mattieu Williams said that it seemed to be assumed that increased brightness was necessarily an indication of increase of temperature; but that, though this might be true for solids, it did not follow that it was true for gaseous bodies. When one gas flame was placed behind another, the brightness was doubled, but the temperature remained the same.

Mr. Ranyard said that the speculations of spectroscopists as to the heat of Sirius were founded on the blueness of its light rather than on its general brightness.

ROTATION OF THE PLANETS.

PROFESSOR PEIRCE has attempted to deduce from the nebular hypothesis an explanation of the actual rotation of the planets on their axis, and reasoning especially with regard to Jupiter and Saturn, he shows that the inner portion of the ring thrown off from the rotating central body must have a less velocity than the outer portion. and consequently there must be a breaking up of the ring, and the formation of planetary bodies. He demonstrates, by a mathematical analysis of the movements of the particles constituting the liquid ring, that the velocity of the resulting rotation must be such as is actually observed.

NEW RELATIONS OF PLANETARY ORBITS.

PROFESSOR DANIEL KIRKWOOD announces the discovery of some remarkable relations of the asteroid orbits to those of the larger planets. Near the close of the last century, Laplace noticed a relation between the mean motions of Jupiter's first three satellites; and from the results obtained by that astronomer, it occurred to Professor Kirkwood that similar relations might probably be found in the zone of minor planets interior to the great masses of Jupiter and Saturn. The investigation has led to interesting discoveries, which the author promises shall soon be published in full. As specimens of the correlations detected, he states the following:

1. Five times the mean motion of Concordia, *minus* nineteen times that of Jupiter, *plus* fourteen times that of Saturn, equals zero. 2. Five times the mean longitude of Concordia, *minus* nineteen times that of Jupiter, *plus* fourteen times that of Saturn, is equal to a semi-circumference, one hundred and eighty degrees.

These discoveries, while tending to throw light upon the genesis of the solar system, may, according to Professor Kirkwood, be explained by the nebular hypothesis of Laplace, or equally well by the accretion theory advocated by Proctor, so that they do not tend to confirm the comparative truth of either supposition.

THE SPECTRA OF PLANETS.

Der Naturforscher, No. 36, contains an account of Herr Vogel's observations on the spectra of the planets. Mercury he finds to give a spectrum most in accordance with that of the sun, and that some bands which are produced by the action of our atmosphere belong to that planet. Venus likewise shows bands like those of our atmosphere. In Uranus numerous lines of the solar spectrum are recognizable, but in the least refrangible parts are a few bands which are like the absorption bands of our atmosphere, and which indicate the presence of water vapor in considerable quantity.

Jupiter's spectrum lines correspond for the most part with those of the sun, but show certain special bands, particularly in the most refrangible parts; a dark band in the red being very noticeable. There are also lines and bands like those of the earth's atmosphere. The gaseous envelope of Jupiter acts on the sunlight like our atmosphere, and the presence of water vapor may be concluded. The band in the red indicates the presence of something not in our atmosphere, or perhaps a different mixture of gases.

Saturn, besides showing a certain correspondence with

the solar spectrum, exhibits special bands in the red and orange, which correspond with our telluric bands, except one intense band where the wave length is 618.2 mill. Mm. The blue and violet rays suffer similar absorption in passing through the Saturnian atmosphere, which is especially noticeable in the spectrum of the dark equatorial belts. The Saturn spectrum corresponds most completely with that of Jupiter; the ring spectrum is faint, and the characteristic band in the red is wanting or feebly seen, from which it would appear that the ring has either no atmosphere, or one of small height and density.

A NEW IDEA ABOUT COMETS.

A PAPER read before the Hackney Scientific Association by Mr. Reeves, advances an entirely new theory with regard to comets. By the use of diagrams, he showed that the part of the comet termed the tail, being always in a direction from the sun, and therefore as often in advance as behind the nucleus, is not really a tail; that, as comets are transparent, and all matter is known to be either solid, liquid, or gaseous, comets must be the latter, for solids and liquids are opaque; that the only known power by which this gaseous matter can be held together is gravity, which must necessarily have a centre, and, every part of the body being free to move, resolves itself into a sphere, the centre of which is in many cases exceedingly dense, gradually attenuating toward the circumference; that the rays of the sun are refracted in their passage through the spherical comet, thus luminating the portion beyond the centre or nucleus, which illumination forms the tail. He then explained how all the various and peculiar phenomena of comets, such as their shapes, colors, horns, nuclei, as well as their being with and without tails, etc., arise; and that they are entirely in accordance with the universal laws of nature.

COGGIA'S COMET.

THE comet which made such a grand display in our northern heavens last year, was discovered by Coggia, at Marseilles, on April 17, 1874. When first seen, the nucleus and coma together had a diameter of 100,000 miles, the comet being then 133,000,000 miles from the earth, and 153,000,000 from the sun. It travels round the sun in the same direction as the planets, but in an orbit the plane of which is very much inclined. Of all the planetary orbits, excepting those of the astercids, that of Mercury is most oblique, having a slant of seven degrees; but the inclination of the orbit of Coggia's Comet is nearly ten times as great, being set down at 66°. Its perihelion passage, or

nearest approach to the sun, occurred on July 8, 1874, when it came within 62,000,000 miles of that orb, and it was then moving at the rate of 160,000 miles an hour. It continued to approach the earth until July 20, coming, on that date, within 26,000,000 miles of us, when it appeared at its brightest, or, according to Professor Parkhurst, 140 times more brilliant than when first discovered. Of its tail, the same authority says: "On June 25, the observed length of the tail was computed as 3,000,000 miles; on July 1, 5,000,000 miles; on July 13, 12,000,000 miles—an increase, after the first of that month, of one-twelfth per day. The tail continued, from its first appearance till the head of the comet ceased to be visible, to point from the latter directly toward the stars Beta and Gamma of the Lesser Bear. Afterward it moved slowly to the westward, so that it covered the dipper of the Great Bear. The speed of the particles leaving the head to form the tail was estimated as over 3,000,000 miles per day.

SPECTRUM OF THE COMET.

FATHER SECCHI has observed the spectrum of Coggia's comet, and finds the lines of carbonic oxide and carbonic acid very brilliant. The same astronomer notes a curious phenomenon which recently happened in Jupiter's first satellite. The atmosphere at the time of observation was quite clear, and the disc of the planet, while plainly defined, presented a slightly wavy surface. As the satellite neared the edge of Jupiter, and had advanced so that a distance of about one of its diameters separated it from the same, the observer was surprised to see the disc apparently extend itself toward the satellite, touch it, and then retract. This to and fro motion continued until the satellite was completely obscured by the planet, a period of four or five minutes. Father Secchi suggests that if similar undulations of the solar disc take place at the time of the passage of Venus, there will be strong elements of uncertainty in the observations, and that it would be desirable to employ means which will reduce to a minimum these effects of atmospheric oscillation.

DISTANCES OF THE STARS.

BY CAMILLE FLAMMARION.—In revolving round the sun, at the distance of 92,000,000 miles, the earth annually describes an ellipse of about 500,000,000 miles. The diameter of this orbit is 184,000,000 miles.

The process for measuring the distance of a star from the earth consists in minutely observing this star at an interval of six months, or better, for a whole year, noting whether it remains fixed, or whether it undergoes some

little appreciable displacement of perspective, owing to the annual displacement of the earth round the sun. If it remains fixed, this is because it is an infinite distance from us—at the horizon of the heavens, so to speak—and our base line of 184,000,000 miles is as nothing in comparison with this remoteness. But if it is displaced, then we know that it annually describes a small ellipse corresponding to the annual revolution of the earth. Every one has remarked, while traveling by rail, how the trees and other objects near at hand move in a direction contrary to our own, their speed being greater in proportion to their nearness; whereas distant objects on the horizon remain fixed. This same effect is produced in space, in consequence of our annual motion round the sun. But though we move incomparably swifter than an express-train, our rate being 1,632,000 miles per day, and 68,000 per hour, the stars are so distant that they scarcely budge. Our 184,000,000 miles of displacement are almost nothing as concerns even the nearest of them. It was not till 1840 that the distance of any of the stars was ascertained. This discovery is, therefore, of recent date, and we are only now beginning to form an approximate idea of the real distances which separate us from the stars.

With great difficulty astronomers have succeeded in determining the parallaxes of *a few* stars. Let the reader only bear in mind that there is not *one* star that is sufficiently near to give us a parallax of *one second!* A second is the dimension to which would be reduced a circle one metre (3 ft. 3.37 in.) in diameter carried away to a distance of 206 kilometres (127.72 miles) from the eye. This appears to be less than nothing: it is equal to the thickness of a hair stretched to the distance from the eye of 20 metres (74 feet). The apparent annual movement of a star, whose distance can be known, is performed altogether within this infinitesimal space. For an observer on a star that is nearest to us, this hair would conceal the whole space between the earth and the sun.

As no star offers a parallax of one second, it follows that the nearest of the stars is distant from the earth not less than 206,265 times 92,000,000 miles. The space which surrounds the planetary system is void of stars to that distance at least.

The star which is nearest to us, Alpha of Centaur, has a parallax of 0."91. Its distance from earth is 226,400 times the radius of the earth's orbit, or 21,000,000,000,000 miles. This is our *neighbor* star, and its distance is probably the minimum distance between star and star—21,000,000,000,000 miles, or twenty one thousand millions of miles.

Each of these stars shines with its own light—is a sun like our own.

The second star, in the order of distances, is 61 Cygni. Its parallax is 0."51, and its remoteness 37,000,000,000,000 miles.

Of the thousands of stars which have been studied, we know the distances of only twenty. Among these we may signalize Sirius, a sun 2,688 times larger than our own, surrounded by a system of heavenly bodies, several of which are already known. and distant from us 82,000,000,000,000 miles; the Polar Star, which is a double star, distant 292,000,000,000,000 miles; and Capella, distant 425,000,000,000,000—a space which is traversed by light in seventy-one years and eight months; so that the luminous ray which reaches us from this fine star in 1874 must have started out in 1803! Capella might have been extinguished in 1804, but we should see it still. It might go out to-day, and yet the inhabitants of the earth would continue to admire it in their heavens until 1946. Conversely, if there existed, on the planets gravitating round Capella, minds whose transcendent vision could thence descry our little earth, lost as it is amid the sun's rays, they would now see the earth of the year 1803, and would be seventy-one years eight months behindhand in its history. These are the stars that are nearest to us. The others are incomparably more remote.

There are stars whose light can not reach us in less than 100, 1,000, or 10,000 years, though light travels at the rate of 185,000 miles per second!

To traverse the sidereal world of which we form part (the Milky-Way), light takes 15,000 years.

To reach us from certain of the nebulæ, it must travel for 300 times that period, or 5,000,000 years.

Let the imagination, that is not appalled by these immensities, strive to conceive of them. If it does not experience the "vertigo of the infinite," let it calmly contemplate these abysses, and realize the position of the earth and of man in presence of them. Thus will it gain some conception of the discoveries made by sidereal astronomy.

Such are the dimensions actually measured in the general constitution of the universe. As yet we are only at the vestibule of the edifice, on the edge of the abyss of infinitude: and we shall never penetrate very far beyond.

THE TRANSIT OF VENUS IN 1874.

IN our last year's RECORD we gave explanations of the transit, with engravings, and alluded to the preparations then going on for the astronomical observation of the event by various governments. We have now to notice the actual occurrence, which took place December 9, 1874, and forms an interesting chapter in the progress of science.

One of the principal results expected to be obtained by the careful observation of the transit of the planet Venus across the disc of the sun, was a knowledge of the correct distance of the great luminary from our earth. One of the earliest transit observations of Venus was made in 1761. Another was made, much more carefully, in 1769, and none has since been had until the present one of 1874. It is known that extensive errors were made in 1769, which, it is hoped, will now be corrected. This will certainly be accomplished if extraordinary care, multiplicity of observations, diversity of stations, and variety in methods of performance are of any avail.

The transit of 1874 was invisible for the most part in Europe and America; but visible in Australia, Northern Asia, and the Antarctic seas. The government of the United States sent out eight expeditions to observe the transit of Venus of 1874, each party being provided with superior instruments, photographic apparatus, etc. The stations selected were Wladivostock, Russia; Nagasaki, Japan; Pekin, China, in the northern hemisphere; and Campbell Island, Kerguelen's Island, Chatham Island, Hobart Town and New-Zealand, in the southern hemisphere. The American observers report good success at nearly all the stations, each taking from fifty to one hundred photographs of the transit, besides many instrumental observations. The governments of England, France, Germany, Russia, Mexico, Italy, and other nations also sent out observing expeditions, all well appointed, and in nearly every case the transit was successfully observed.

The next transit of Venus will take place in 1882, but after that none will occur until the year 2004.

COLLISION OF STARS.—Mr. G. J. Stoney, F.R.S., read a paper on the results which would take place supposing two stars to come into collision, the effect being a great increase in light and heat. He pointed out that there might be many cold or dark stars in space, of which science knows nothing. There are some stars which appear and disappear at intervals. This might be due to one star passing and "wiping" another. — *British Association Reports.*

MISCELLANEOUS.

ANCIENT STONE FORT IN INDIANA.

By Prof. E. T. Cox.—Of the many ancient works scattered over the greater portion of the United States, indeed, I might add over North and South America, there are none which possess greater interest for the student of archæology than the stone and earthwork inclosures built by the race of men who inhabited the country at a time so remote in the past history of the country, that the tradition of the race of men who preceded them can not furnish us with any trust worthy clew to their history, though they were evidently a powerful race living under organized governments, at the head of which there was, probably, a powerful and despotic ruler whose will was law; yet, amid all the remaining records of their greatness, no trace has been found of a national name, consequently they have been classed under the general name of "mound-builders."

Without relating the many evidences which lead to the inference that the mound-builders of the United States had their origin in Central America, where civilization and arts attained a degree of perfection unsurpassed, if equaled, by the earlier evidences of art in the Old World, I will merely add that in their emigration to the northward they followed the shore lines of the oceans and gulfs, and penetrated to the interior by the great rivers and their tributaries, and took possession of such river sites for their towns and forts as our forefathers subsequently saw fit to adopt as sites for founding some of our present flourishing cities.

One of the most remarkable works left by the mound-builders is seen in Clarke County, Indiana, fourteen miles above the Falls of the Ohio River. It is an ancient stone fort, built upon the terminal point of a high ridge, which is washed on the south side by the Ohio River, and on the north by Fourteen Mile Creek, a broad and deep stream which empties into the Ohio a few miles below. The point of the ridge is pear-shaped, and the fortification includes from eight to ten acres. The highest point at

the stem of the pear is 280 feet above the Ohio River, and is here only 10 to 20 feet broad, with the coniferous limestone two to three feet thick, exposed at the surface, and the Niagara limestone beneath, and reaching down in an almost perpendicular wall to the river. A natural wall of Niagara limestone furnishes complete protection against the approach of an enemy at the upper part of the fort, with the exception of a short gap on the creek side, extending from the upper point southward for about 100 steps. This break in the natural wall is protected by an artificial wall seventy-five feet in height, made by laying up loose stone, mason fashion, but without mortar. The base for 65 feet in height follows the slope by the hill, and then rises 10 feet vertically. Around the southern terminus of the point there is an artificial stone wall 10 feet high, which connects the two natural walls of Niagara limestone, thus forming a complete barrier to the approach of foes. On the inside of the made wall are numerous mounds of earth, and within the line of these mounds there is a dug ditch four feet deep and twenty feet wide, which receives the draining from the crown of the hill.

A trench was dug through one of these mounds, and we found slabs of stone set upon edge and leaning in the direction of the slope of the mound. They extended in for two feet, and were arranged so as to protect the mound from the overflow of the ditch. Some pieces of charcoal, ashes, decomposed bones, and a large diamond-shaped rock, having a slight indentation near the centre of the top surface, and worn quite smooth, are all the relics we could find in it. On top of the ridge there are also a number of mounds, and the ground slopes very gradually from the northern to the southern extremity, the former being 280 and the latter 160 feet above the river. (144)

HUMAN LOCOMOTION.

PROF. E. J. MAREY, of the College of France, has devised an apparatus which, applied to the extremities of a moving animal, enables each limb to write out a description, or make a picture of its own actions, so that the duration and phases of its movements, its periods of rest, and the relations of these to the corresponding features in the motions of the other limbs, may be seen at a glance.

The machine may be described as consisting of two parts, one of which is applied to the limb, and is called the *experimental shoe*, while the other is carried in the hand of the operator, and is simply a registering instrument, connected with the shoe by an india-rubber tube. The

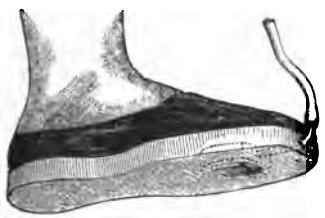

FIG. 1.—EXPERIMENTAL SHOE.

experimental shoe is made by fixing under the sole of an ordinary shoe, with heated gutta-percha, a strong sole of india-rubber about five-eighths of an inch thick. Within this sole there is an air-chamber, which, in Fig. 1, is represented by dotted lines.

This chamber, having upon it a small piece of projecting wood, is compressed at the moment the foot exerts its pressure on the ground. The air expelled from this cavity escapes by the tube, actuating the recording instrument in the hand of the experimenter, causing it to register the duration and phases of the pressure of the foot.

FIG. 2.—RUNNER WITH REGISTERING APPARATUS.

The registering instrument consists of a little drum, with its upper side formed of some elastic membrane. On this membrane rests a lever having the point of its long arm in contact with the surface of a revolving cylinder, which may be made to move at any required rate, and which carries a slip of paper prepared to receive the tracings. Fig. 3 is a representation of this instrument as employed in registering the transverse dilatation of muscular fibre in the process of contraction. If we substitute in this figure an experimental shoe for each of the myographical clips, 1 and 2, we shall have

the arrangement of the apparatus necessary for the study of *footsteps* or *impacts* of the foot on the ground.

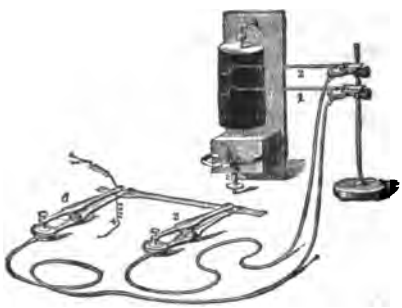

FIG. 3.—THE MYOGRAPHICAL CLIPS AND REGISTER. THE CLIPS NUMBERED 1, 2.

The entire apparatus, as adjusted to the person of the operator, is seen in Fig. 2. The piece of machinery on the head serves to record the movements communicated to the trunk by the actions of the legs. It is shown enlarged in Fig 4.

The experimental shoes constitute a sort of dynameter of pressure; they compress the drum less or more, according to the effort they exert, and consequently transmit to the registering level more or less extensive movements. In walking, the pressure of the foot on the ground is not only equal to the weight of the body, which the foot sustains, but a greater effort is produced at a given moment in order to elevate and move the body forward. This additional effort, in a man of average weight, is estimated at about forty pounds, and it is much greater in running and leaping.

With each step there is an up-and-down movement of the body, which varies with the length of the step and the rapidity of the pace. In ordinary walking it has an amplitude of from half to three-quarters of an inch. The maximum of these vertical oscillations is constant, and occurs during the pressure of the foot upon the ground, at the moment when the leg is brought into a straight position. The minima, and consequently the extent of the oscillations, will be determined by the length of the step; the longer the step the greater the obliquity of the legs, and, of course, the greater the lowering of the trunk. Put in another form, it amounts to this: in ordinary walking, the body does not rise above the line of its greatest height when standing still, and the distance which it sinks below this line will increase as the length of the step increases.

FIG. 4.—INSTRUMENT TO REGISTER THE VERTICAL MOVEMENT.

The instrument by which M. Marey obtains the tracings of these vertical reactions is represented in Fig. 4.

It is an experimental level-drum, fixed on a piece of wood, which is fastened with molding-wax on the head of the experimenter, as seen in Fig 2. The drum is provided with a piece of lead placed at the extremity of its level; this mass acts by its *inertia*. While the body oscillates vertically, the mass of lead resists these movements, and causes the membrane of the drum to sink when the body rises, and to rise when the body descends. From these alternate actions a current of air results, which, transmitted by a tube to a registering lever, shows by a curve the oscillatory movements of the body.

A complete horizontal oscillation occupies the time of two steps, and, consequently, of two vertical oscillations. The body is carried toward the right side, at the moment of the maximum of elevation, which corresponds with the middle of the pressure on the right foot, and toward the left at the middle of the pressure on the left foot. This lateral swaying of the trunk is the consequence of the alternate passage of the body into a position sensibly vertical over each foot.

The body is advancing at every moment during the step, but at some parts of it more rapidly than at others. The greatest rapidity of advance is at the end of the pressure of the foot.

In walking, the body does not leave the ground, the footsteps follow each other without any interval, and the weight of the body passes alternately from one foot to the other.

Running, though more rapid than walking, consists like it in alternate treads of the two feet, whose step-curves follow each other at equal intervals; but it presents this difference, that in running the body leaves the ground for an instant at each step. The pressures of the feet are more energetic than in walking; in fact, they not only sustain the weight of the body, but impel it with a certain speed both upward and forward. It is clear that, to give a mass a rising motion, a greater effort must be exerted than would be sufficient simply to sustain it. The duration of the pressures on the ground is less than in walking; this brevity is proportional to the energy with which the feet tread on the ground. These two elements—force and brevity of pressure—increase generally with the speed at which a person runs. The essential character of running is *the time of suspension*, during which the body remains in the air between two foot-falls. The dura-

tion of the time of suspension appears to vary but little in an absolute manner; but, if we compare it with the speed of the runner, we see that the relative time occupied by this suspension increases with the speed of the course, for the duration of each tread diminishes in proportion to this speed. How is this suspension of the body, at each impulse of the foot, produced? We might at first think that it is the effect of a kind of leap in which the body is projected upward in so violent a manner, by the impulse of the feet, that it would describe in the air a curve, in the midst of which it would attain its maximum elevation from the ground. Such is not the case. The body executes each of its vertical elevations during the *downward pressure* of the foot, so that it begins to rise the moment the foot touches the ground; it attains its maximum elevation at the middle of the pressure of this foot, and begins to descend again in order to reach its minimum at the moment when one foot has just risen, and before the other has reached the ground. This relation of the vertical oscillations to the pressure of the feet shows plainly *that the time of suspension* does not depend on the fact that the body projected into the air has left the ground, but that the *legs have withdrawn from the ground* by the effect of their flexion; and this takes place at the very moment when the body was at its greatest elevation.

Among the characters belonging to the various modes of progression, the rhythm of the impact of the feet is one of the most striking. The strokes of the feet upon the ground give rise to sounds the order of whose succession is sufficient for a person, with an ear accustomed to them, to recognize the kind of pace which produces them. In order to give the figure of each of these rhythms, Prof. Marey employs the musical notation, modified so as to furnish at the same time the notion of the duration of each pressure, that of the foot to which this pressure belongs, and also the length of time during which the body is suspended. This notation of rhythms is constructed in a very simple manner from the tracings furnished by the apparatus.

Between the pressure of the two feet there is found to be silence in the rhythm; that is to say, the expression of that instant of the course when the body is suspended above the ground.

If we note in this manner the rhythms of all the paces used by man, we shall obtain a synoptical table which will much facilitate the comparison of these varied rhythms.

Fig. 5 represents the synoptical, of the four kinds of progression, or paces, which are regularly rhythmical, and in which the two feet act alternately. Line 1 represents the notation of the rhythm of the walking-pace. The pressure of the right foot upon the ground is represented by a thick white stroke, a sort of rectangle, the length of which corresponds with the duration of the pressure. For the left foot there is a grayish rectangle, shaded with oblique lines. These alterations of gray and white express by their succession that in walking the pressure of one foot succeeds the other, without allowing any interval between the two.

FIG. 5.—SYNOPTICAL NOTATION OF PROGRESSION.

Line 2 is the notation which corresponds with the ascent of a staircase. It is seen that the strokes lap, or encroach on each other, and that, consequently, the body during an instant rests on both feet at once.

Line 3 corresponds with the rhythm of running. After a shorter pressure of the right foot than in the walking-pace, an interval is seen which corresponds with the suspension of the body; then a short pressure of the left foot, followed by a fresh suspension, and so on continually.

Line 4 answers to a more rapid rate of running. It shows a shorter duration of the pressures, a longer time of the suspension of the body, and a more rapid succession of the various movements.

NEW-YORK TO BE THE LARGEST CITY.

PROFESSOR JOSEPH HENRY, President of the Smithsonian Institution, thinks that New-York is destined to become the largest city in the world. His views are based upon the fact that there is "no other city having so large a country tributary to it in the richest productions of the soil and mine, and no other city so favorably situated in regard to geography and topography to secure these tributaries perpetually to itself. There are, in fact, but two outlets for water communication from the immense region of the basin of the Mississippi; namely, that along the river itself into the Gulf of Mexico near New-Orleans, and that along the great lakes and the Hudson, terminating at New-York in the Atlantic ocean."

THE AGE OF EXISTING RACES OF MEN.

In an address delivered before the International Congress of Orientalists in London, Professor Richard Owen said that ethnologists are too often led into error by looking upon the present condition of the earth's surface as older than it really is. The old idea of a cataclysmic close to each of the geologic periods having been removed, it is time to take into consideratiou the fact that the position of a primitive people may have changed from continental to insular by such gradual topographical alterations as would leave no traces in their language or traditions. He thinks that existing races of men date from a much more remote period than is generally supposed, and supports his argument by pointing to the manifest effect upon races of some of the later geological movements. He points out that the ancient Egyptians, of whom, fortunately, we have admirably-preserved ethnological and artistic remains, closely resemble in the characteristics which mark an advanced and intelligent people the modern Europeans, and concerning them he says: "In our present palæontological evidence of the antiquity of the human race, seven thousand years seems but a brief period to be allotted to the earliest, the oldest civilized and governed community. That a race with the physiognomical characters here exhibited should have risen so early to that high estate along the Nile accords with the unique blessedness of the soil and climate of Egypt, and with the high racial characters of the people flourishing under its antediluvian Pharaohs. This term, of course, is arbitrary, for Egyptian records tell nothing of a cataclysmal deluge. The land was never visited by other than its annual beneficent overflow. The deposits of that overflow, which would have been swept out of the valley which the Nile has excavated by a diluvial wave, testify as strongly as the volcanoes of Auvergne and the cataract of Niagara against the operation of any such geological dynamic at the Septuagintal date, or any earlier." He does not attempt to give dates, nor any exact measure of the time which has elapsed since the Egyptians had their beginning as a race, but merely points out that the teachings of geology and natural history account for a length of time sufficient for any racial development. The Isthmus of Suez is of comparatively recent geological origin, belonging to the early miocene, but it has been raised above the water's level long enough to permit a marked separation of animal species living in the Red Sea and the Mediterranean—species that must have been at one time identical or closely allied, occupying, as they did, closely neighboring habitats in the same

sheet of water. "Only the zoological mind," says Professor Owen, "can conceive or attempt to grasp the lapse of historical time so indicated." He further shows that Egyptian paintings at least three thousand years old accurately represent certain races in the precise characteristics which mark them now, and he concludes that there is ample ethnological evidence for extending the existence of the present races to a period far beyond that commonly assigned them. "With this evidence of the extreme varieties of mankind one thousand five hundred years B. C., which subsequently have undergone little or no amount of change, the probability is great that in the time of Thothmes, but three thousand years ago, there existed also red men in America, Maories in the Pacific, Mongols in China, Anios in Japan, Papuans in New Guinea, Tasmanians, not then nearly extinct, near the Antarctic circle, Esquimaux at the opposite pole, and a wide dispersion of sub-varieties of the negro race over the African continent. Physiology compels a retrospect far beyond historical periods of time for the establishment of these varieties." (116)

POPULATION OF THE UNITED STATES.

THE first census of the country was taken in 1790, and decennial censuses have been taken ever since. An estimate has been made for the ten years previous to 1790, from the data of years 1790, 1800, 1810, and 1820. An examination of these years exhibited successively by subtraction two second differences that were nearly equal, so much so as to indicate in general, as the law of their progression, approximately, constant second differences. From the average of these second differences, treated as a second difference for completing the series, the population for the year 1780 was estimated at 3,070,000.

The present and prospective population of the United States is as follows:

1870	38,558,371	1876	45,316,000
1871	39,555,000	1877	46,624,000
1872	40,604,000	1878	47,983,000
1873	41,704,000	1879	49,395,000
1874	42,856,000	1880	50,858,000
1875	44,060,000		

SMOKING BY CLOCK-WORK.

A NEW toy, lately patented, consists of a figure of a dandy with a cigar-holder in his mouth. In the pedestal there is a small bellows, operated by clock-work and spring. A small cigar is lighted and placed in the holder, and when the spring is set in motion, the dandy puffs away, as natural as life, until the cigar is consumed.

THE PALACE OF MONTEZUMA.

THE ancient palace of Montezuma, in the heart of the city of Mexico, where that unfortunate monarch was seized and made captive by the treachery of the Spaniards under Cortez, is described as having been a place of great magnificence. It was full of sculptured arches, pillars, and beautiful fountains. On the consummation of the Spanish conquest, it was converted into the Roman Catholic convent of San Francisco, and became one of the most wealthy and powerful religious institutions of the kind in the New World.

Church and State have, until within the past few years, been always united in Mexico; but a few years ago, under President Juarez, the Congress decreed a separation, and ordered the sale of all church property.

The American Methodists bought the palace last year for mission purposes, for the sum of $16,500, and, having cleaned up and repaired the building, it has been publicly dedicated to Protestant worship. The walls are five feet thick, and it is built in the most strong and enduring manner. Much of the beautiful original sculpturing still remains, and it could not now be recut, it is said, for less than $100,000. The Methodists have room upon the premises for printing offices, schools, parsonages, etc., and expect, one of these days, to make it the centre of a very extensive scene of educational operations.

IN the new picture called the "Roll Call," which lately received the highest honors in the London Academy, the artist represents a horse walking, in which act the legs on one side of the animal are moved together. Several critics asserted that this is wrong, and that the motion in walking is the same as in trotting, when the near fore-leg moves with the off hind-leg. According to Dr. Pettigrew, who has made the movements in animal locomotion the subject of scientific investigation, the critics are right. The movement is the same in walking as in trotting, only slower.

FORMOSAN BURIAL.

REV. MR. SWAYNE, from Formosa, gives an account of a mode of sepulture which connects itself with the hut burials described by Nillson and Lubbock. When a man dies the hearth-stones are removed from the centre of the hut, and a pit is dug about four feet deep. The body is placed therein, together with food and his dress and implements. The hole is then filled up, the earth is packed down, the hearthstones are replaced, and every thing goes on as formerly.

THE RAILWAYS OF THE UNITED STATES.

THE inauguration of railways in this country may be said to date from the year 1830, when railways were in operation to the extent of 23 miles. At the close of 1873 there were *seventy thousand, six hundred and fifty-one miles* of railway in operation. This great increase, during the brief time of forty-three years, is something marvelous to contemplate. The grand average cost is put down by Mr. Poor at $60,000 per mile, or upward of four thousand millions of dollars in the aggregate. The total earnings were over $526,000,000 and the operating expenses 65 per cent thereof, or $342,600,000, leaving as net earnings the sum of $183,810,000, out of which interest on bonds and stock dividends were paid. The average of the latter were 3.45 per cent on the capital stock, the aggregate of which is one thousand nine hundred millions of dollars.

The aggregate of railways in 1873 in the various countries of Europe was as follows: Germany, 12,207 miles; Austria, 5,865; France, 10,333; Russia, 7,044; Great Britain, 15,814; Belgium, 1,301; Netherlands, 886; Switzerland, 820; Italy, 3,667; Denmark, 420; Spain, 3,401; Portugal, 453; Sweden and Norway, 1,049; Greece, 100.

	Miles.	Population.
Railroads in 1873 in Europe	63,360	282,456,742
" " United States	70,650	40,232,000

THREE THOUSAND FIVE HUNDRED MILES BY RAILWAY.

THE new route between San Francisco and New-York is thus composed:

	Miles.
Central Pacific—San Francisco to Ogden	878
Union Pacific—Ogden to Kearney	835
Burlington and Missouri River, in Neb.—Kearney to Hastings	40
St. Joseph & Denver City—Hastings to St. Joseph	226
Hannibal & St. Joseph—St. Joseph to Hannibal	206
Hannibal to Louisiana	25
Chicago & Alton—Louisiana to Chicago	275
Michigan Central—Chicago to Detroit	284
Great Western—Detroit to Suspension Bridge	230
New York Central—Suspension Bridge to New York	447
Across the Continent	3,446
TO BOSTON.	
San Francisco to Chicago	2,485
Chicago to Albany	818
Albany to Boston	201
	3,504

THE maximum cost of transporting railway freight, last year, between New-York and Chicago, was 7 mills per ton per mile. The total cost of moving freight by canal (horse-power being used for towage) is 5 mills per ton per mile.

EDUCATED BIRDS.

THE Baltimore *American* gives the following account of a troupe of trained Java sparrows and parroquets, recently exhibiting in the streets of that city:

When a suitable place is found, a circular table is opened and the birds are all turned loose upon it; they manifest no fear at the crowd, and do not offer to escape. The performance consists of ringing bells, trundling small wheelbarrows, slack-wire walking, firing off pistols, dancing, swinging each other in small swings, an excellent imitation of a trapeze performance, and a number of other equally interesting tricks. The most wonderful part of the performance, however, is done by a parroquet. This bird walks to the centre of the table, and after bowing to the crowd, seats himself in a small chair near the bell. To the clapper of the bell there is attached a small cord, and any one in the crowd is allowed to ask the bird to strike any number of times on the bell. If asked to strike ten times, he leaves the chair, seizes the bell-rope and pulls it ten times, after which he bows and returns to his seat. This was repeated a great many times, and with one exception the bird made no mistake. The bird will strike twenty-seven times, but after that he refuses; and his owner states that he has worked nearly a year to get this bird to strike up to thirty, but it appears that his memory gives out at that point, and it is unable to count further. A collection is, of course, taken up after each exhibition.

CULTIVATION OF PRAIRIE CHICKENS.

QUITE an extended movement is taking place having for its object the introduction of prairie chickens, or the pinnated grouse, from the West into the scrubby lands of the Eastern States, and especially of Long Island. An augury of success is furnished by the fact that when the country was first discovered these birds were extremely abundant in many parts of New-Jersey, Pennsylvania, Long Island, and the islands and coasts of the New-England States as far as Cape Cod. They have, however, been almost entirely exterminated, a few only existing in the mountain region of Pennsylvania, in Martha's Vineyard, and possibly in parts of Long Island. According to a memorandum in *Forest and Stream*, two pairs of grouse were obtained about five years ago and placed in the vicinity of Snow Hill, Maryland. The first season they raised twelve or thirteen young, and it is now estimated that in that section of country the number has risen to about two thousand. The residents in the neighborhood of this experiment take great interest in it, and are very particular not to allow any mo-

lestation. The passage of a law was also obtained forbidding their being killed for five years.

English sportsmen are now taking measures to introduce the same species into Great Britain and Ireland, with what success remains to be seen.

THE AINOS.

IN the Journal of the Anthropological Institute, Lieutenant Swinton C. Holland, R.N., gives an exceedingly interesting paper upon the Ainos, or the supposed aborigines of Yesso, Saghalien Kunashir, and the most of the Kurile Islands. Although in utter subjugation to the Japanese, they are a distinct race, in form, language, clothing, building, navigation, feasts, and superstitions. The men are of middle stature: they carefully cultivate the beard and mustache, never using knife or scissors upon them. Their bodies are also covered with coarse hair, growing profusely on the breast, arms, and legs, and in some cases even over the backbone.

Their only method of computing time is by great events, as, for example, the time of the great snow-storm, the catching of the big fish, etc. They preserve a rough record of their ancient history in songs and tales. The mode of saluting among the men is to rub the hands together, raise them to the forehead, palms up, and then to stroke the beard. Among the women the custom is to draw the first finger of the right hand between the first finger and the thumb of the left; then to raise both hands to the forehead, palms up, then to rub the upper lip under the nose with the first finger of the right hand. When a man has been traveling and returns home, he and his friend lay their heads on each other's shoulders: the elder of the two then places his hands upon the head of the younger, and strokes it down, gradually drawing his hands over the shoulders, down the arms, and to the very tips of the fingers of the younger; until this is done neither speaks a word.

When a person dies all mention of him ceases; his house is either burned or deserted, and his utensils, however coveted or desired by his surviving neighbors, are left untouched.

They worship the spirits of their ancestors, of the elements, and of natural objects. The most sacred animal seems to be the bear, the young of which are caught and suckled by women. When weaned they are kept in sacred cages. and fed for two or three years. They are then killed and eaten with great ceremony, while their skulls go to adorn the tops of the posts of the sacred stockade.

A HUMAN SKULL IN SOLID ROCK.

A VERY strange discovery, interesting to geologists, is reported by the Osage Mission (Kansas) *Journal*. A human skull was recently found near that place imbedded in a solid rock which was broken open by blasting. Dr. Weirley, of Osage Mission, compared it with a modern skull which he had in his office, and found that though it resembled the latter in general shape, it was an inch and a quarter in greatest diameter, and much better developed in some other particulars. He says of the relic: "It is that of the cranium or human species, of large size, imbedded in conglomerate rock of the tertiary class, and found several feet beneath the surface. Parts of the frontal, parietal and occipital bones were carried away by the explosion. The piece of rock holding the remains weighs some forty or fifty pounds, with many impressions of marine shells, and through it runs a vein of quartz, or within the cranium crystallized organic matter, and by the aid of a microscope presents a beautiful appearance. Neither Lyell nor Hugh Miller, it is stated, nor any of the rest of the subterranean explorers, report anything so remarkable as this discovery at Osage Mission. The Neander man comes nearest to it, but the Neanderthal bones were found in loam only two or three feet below the surface, whereas this Kansas skull was discovered in solid rock."

NO COAL IN CALIFORNIA.

DR. J. C. COOPER, who has made the most careful surveys of the State, says that the geological facts are all against the probability of the existence of any true coal measures in California. In ninety-nine cases out of a hundred, the alleged coal discoveries are of no value whatever. In other countries, the true coal of the carboniferous rock is formed of tree ferns, algæ, and other plants of low organization. None of these remains are found in California, but in their stead are found the remains of coniferous and dicotyledonous trees, or those having double-lobed leaves, the beds in which they are found being classed by geologists as lignites. In some parts of the State, this lignite is found in useful quantities, and may be employed, like peat, for local consumption.

COLORADO MINES.—The area of land known to be rich in gold deposits in Colorado is about 7,200 square miles, lying in various parts of the territory, on both sides of the main range. There can be hardly a doubt but that this extent will be largely increased in coming years, for new discoveries are constantly being made upon the foot-hills and plains.

NEW AFRICAN DISCOVERIES.

CAPTAIN SPEKE in 1862 reached the borders of Victoria Lake, and, as his narrative describes the journey, penetrated on the White Hill River as far as 1° north latitude, discovering the other arm of the delta or the Luageri River. More recently Sir Samuel Baker visited the same locality and explored the region thereabout, with the exception of some fifty miles, which, owing to the hostility of the natives. he was unable to penetrate.

It has been reserved for an American officer, Col. Long, to accomplish this arduous task alone, and the result of his exploration has been the discovery of another great lake in 1° 30′ latitude some twenty-five miles long. From this body of water it appears flows the river which empties into Lake Albert. If further examination confirms this probable fact, Lake Tanganyika is eliminated from the problem of the Nile sources, and proved to be simply a supply for the rivers flowing to the Atlantic coast—so that the long-sought source must be either in Victoria Lake or else in this new lake, which is possibly an extension of the latter.

LAKE OKEECHOBEE.

MR. FREDERICK OBER announces the result of an exploration of Lake Okeechobee, a very little-known body of water in South Florida, around which a halo of romance has been thrown in consequence of mysterious references to ancient ruins of vast extent, and wonderful forms of animal life, such as spiders weighing several pounds, etc. As might have been expected, however, from a knowledge of the surrounding regions, no such objects were met with, and the ruined cities proved equally to be myths.

Mr. Ober reports that the only practicable route to Lake Okeechobee is that *via* Kissimmee River, which is descended until the lake is reached. The latter proves to be about forty miles long and twenty-five broad. It is very shallow, nowhere showing a greater depth than twelve feet, while shallows extend for miles into the lake. Very few fish were found, and even alligators were scarce. Birds, with the exception of the fish-hawk, courlan, snake-bird, and herons of various species, were not seen.

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BONE CHARCOAL.—Compact bones, such as marrow-bones, give more charcoal, and of better quality, and yield less ammonia, oil, and gas, while the converse holds with light bones.

THE AKKAS.

THE Italian Geographical Society has recently received news of the death of the African explorer, Miani, and also a number of interesting objects forwarded to them by that traveler just previous to his decease. Among the curiosities were two African dwarfs belonging to the tribe of Akkas. These individuals, aged respectively 18 and 19 years, are but 28 and 34 inches in height, and belong to a peculiar race of people, the existence of which, first affirmed by Herodotus, has of late years been rediscovered by Du Chaillu and Schweinfurth. These strange beings are of a light copper color, and noticeable for their extreme ventral prominence and very thin members. The lips are very long, the chin sharply recedes, and the hair, though tightly kinked, is very long and abundant. Their agility is said to be remarkable, in view of their peculiar build.

TERRA DEL FUEGO.

THE French expedition which has been exploring Terra del Fuego reports the finding, in the interior, of a large lake, 15 miles in circumference, surrounded by luxuriant vegetation, and literally covered by an army of wild fowl, among which the most abundant were ducks and geese. These regions are inhabited by rude but hospitable tribes; the women especially are very affable and obliging. One of them, in exchange for some pieces of sugar and common handkerchiefs, gave the leader of the expedition an object to which she attached an immense value, and which she preserved as a relic—the lid of a sardine-box.

THE WARM SPRINGS OF COSTA RICA.

A. V. FRANTZIUS states that these springs, more than 30 in number, may be regarded as a continuation of the remarkable series of warm mineral springs discovered by Humboldt in Venezuela, and extending for 150 miles from Cape Paria to Merida. The Costa Rica springs begin, indeed, 13 degrees of longitude farther west, but are situated under nearly the same parallel of longitude, viz., 10° N. in a strip of land running for 30 miles from east to west. Most of them occur in narrow mountain gorges on the banks of rivers, or are even overflowed by the rivers, so that they are visible only in the dry season. Their temperature is higher in proportion as they are situated at a lower level. The highest observed temperature is 157.1°. The water contains some salt.

THE ASTOR LIBRARY.

By the munificent endowment of the late John Jacob Astor, and of his son William B. Astor, the splendid institution known as the Astor Library was founded in this city. Its doors are open free of charge to all comers, and here the reader may call for any books on the catalogue and spend as long a time in their study in the alcoves of the library as he desires. There are 147,640 books and pamphlets now upon the shelves, which, with the building, have cost something over $700,000. The twenty-fifth annual report shows that during the past year 116,694 volumes were given out to readers, of which about one half were books relating to the department of science and art; and of the twenty divisions of this department, by far the largest number of books called for by alcove readers were those relating to patents. This is an instructive fact, showing the useful influence of our patent laws in leading people to study upon the recorded knowledge of subjects which have specially engaged their minds.

ROMAN REMAINS.

An important discovery has been made at Highwood, near the village of Ashill, in Norfolk, England, consisting of a vast collection of Roman remains in an oak-lined well, sixty feet deep. The Norfolk and Norwich Archæological Society recently visited the spot, when the well, under the superintendence of Mr. Barton, was emptied of its contents by a number of workmen. The well contains a great variety of articles, the most abundant being urns, of which about 100 have been obtained; more than fifty of these are perfect, and many of most beautiful form and ornamentation. There is considerable doubt as to the purpose which these wells were intended to serve; there are two others at Ashill, and others have been found elsewhere.

NORWEGIAN ANTIQUITIES.

At a recent meeting of the California Academy of Sciences, R. E. C. Stearns read an interesting translation from the reports of the Society for the Preservation of the Norwegian Antiquities. It described the excavation of an ancient vessel, of the Viking period, found in the parish of Tane, Norway. It was the custom of the Vikings to convert one of their vessels into a sarcophagus, on the death of a great warrior. The vessel was conveyed inland, the remains of the hero deposited in the hull, with his armor, weapons, the bones of his war chargers, and the whole covered with earth. These *tumuli* have been discovered and excavated in various parts of Norway, and the peculiarities of ancient marine architecture exposed for inspection.

HUMAN LIFE IN BRAZIL.

DR. CONTO DE MAGALHAES has just published at Rio Janeiro a work in Portuguese upon the anthropology of Brazil, consisting of a collection of papers and addresses before learned societies by the author. He concludes that man has existed in Brazil one hundred thousand years; that some of the native languages (the Quichua, for instance) have borrowed about two thousand roots from the Sanscrit. He makes the tall dark tribes, like the Guaicurù of Matto Grosso, to be the primitive stock, and derives the other shorter and lighter races from a mixture of these with white races in prehistoric times.

FOSSILS OF THE DEPARTED.

A GERMAN inventor, Dr. Von Steinfels, seems to have hit a happy medium for disposing of the dead, which is at least free from the objections urged against burial, while it does no violence to the feelings which naturally shrink from destroying by fire the corpse of a beloved friend. It is proposed to place the body in a sarcophagus made of stone, and to pack around the corpse artificial stone or cement in a plastic state. The latter being allowed to harden, the remains become like a fossil imbedded in the solid rock, and, if need be, the deceased finds his grave and his monument in one and the same mass.

STRENGTH OF GLASS TUBES.

M. CAILLETET has found that a tube of thin glass, 20½ inches in length and ¼ of an inch in diameter, was crushed by an exterior pressure of 1,155 lbs. to the square inch, while similar tubes were burst by an interior pressure one half less. In making use of very thick glass, capable of resisting a pressure of four or five hundred atmospheres, he found the glass to sustain no permanent change of form. Upon this fact, he proposes the construction of a very sensitive and simple manometer.

THE ESCAPE-BOX.

THE Parisian thief, when he finds arrest unavoidable, is seen to swallow a glistening object, known as the escape-box. It is a small tube of polished steel, three inches long, and contains miniature turn screws, hammers, saws, thread, etc., and other implements to assist escape. Sometimes, however, it refuses to glide along the intestinal canal as expected, and causes death. When, however, it does reappear, the thief is in possession of implements with which he can saw through the thickest bars. Five or six thieves die annually in the Paris prisons by the stoppage of these boxes in their bowels.

CONSUMPTION OF PAPER.

SIGNOR EUGENIO MORPURGO has recently published, at Venico, a monograph on paper-making. In this it appears that the United States consumes more paper than England and France united. The average consumption is 17 lbs. per capita. In Russia, it is 1 lb.; in Spain, 1½ lbs.; in Austria and Italy, 3½ lbs.; in France, 7 lbs.; in Germany, 8 lbs.; and in England, 11½ lbs.

GREAT GEYSER OF MONTANA.

A NEW, and, if all reports be true, a most remarkable geyser basin exists in Montana. It is represented as much more extensive than any of the already explored basins, and to contain geysers of much greater force and volume than any yet described by tourists. One of these newly-discovered geysers is estimated to throw a volume of water 40 feet in diameter over 500 feet high, and to continue in eruption from ten to fifteen minutes. It is also stated that in this basin there are mud-volcanoes far surpassing in volume and eruptive force those on the upper Yellowstone. This wonderful region is stated to be about twenty-five miles southeast of the summit of Mt. Washburn.

CAMPHOR FOR SEEDS.—According to A. Vogel, camphor is found to have a marked effect in stimulating the germination of seeds, both by shortening the period of germination and causing more seeds to sprout. Turpentine has a similar action, but seems to exert a hurtful influence on the further development of the plant, which is not the case with camphor.

EXPLOSIVE DIAMONDS.—Some of the diamonds found in South Africa are said to be explosive, the explosion usually taking place in the first week of the stone's exposure to the air. In some cases, however, the occurrence has been deferred for three months. Steeping in tallow prevents the accident, but it is evident that diamonds which can be preserved only in this way can have little value.

A SORT of flute, dating from the age of polished stone, has been found by E. Piette in a layer of charcoal and cinders, in the cavern of Gourdan, Haute-Garonne, associated with flint implements of neolithic types. The instrument is of bone, and pierced with two well-made holes. This is the first discovery on record of a musical instrument belonging to prehistoric man.

STATUE OF JOSEPH PRIESTLEY, BIRMINGHAM.

BIOGRAPHY.

JOSEPH PRIESTLEY.*

If the man to perpetuate whose memory we have this day raised a statue had been asked on what part of his busy life's work he set the highest value, he would undoubtedly have pointed to his voluminous contributions to theology. In season and out of season, he was the steadfast champion of that hypothesis respecting the Divine nature which is termed Unitarianism by its friends and Socinianism by its foes. Regardless of odds, he was ready to do battle with all comers in that cause; and, if no adversaries entered the lists, he would sally forth to seek them.

To this, his highest ideal of duty, Joseph Priestley sacrificed the vulgar prizes of life, which, assuredly, were within easy reach of a man of his singular energy and varied abilities. For this object he put aside, as of secondary importance, those scientific investigations which he loved so well, and in which he showed himself so competent to enlarge the boundaries of natural knowledge and to win fame. In this course, he not only cheerfully suffered obloquy from the bigoted and the unthinking, and came within sight of martyrdom, but bore with that which is much harder to be borne than all these—the unfeigned astonishment and hardly disguised contempt of a brilliant society, composed of men whose sympathy and esteem must have been most dear to him, and to whom it was simply incomprehensible that a philosopher should seriously occupy himself with any form of Christianity.

I am sure that I speak not only for myself, but for all this assemblage, when I say that our purpose to-day is to do honor, not to Priestley, the Unitarian divine, but to Priestley, the fearless defender of rational freedom in thought and in action; to Priestley the philosophic thinker; to that Priestley who held a foremost place among "the swift runners who hand over the lamp of life,"* and transmit from one generation to another the fire kindled,

* Extracts from an address delivered by T. H. Huxley, LL.D., F.R.S., on the occasion of the presentation of a statue of Priestley to the town of Birmingham, August 1, 1874.

* "Quasi cursores vitaï, lampada tradunt."—Lucretius, "*De Rerum Nat.*," ii., 78.

in the childhood of the world, at the Promethean altar of Science.

The main incidents of Priestley's life are so well known that I need dwell upon them at no great length.

Born in 1733, at Fieldhead, near Leeds, and brought up among Calvinists of the straightest orthodoxy, the boy's striking natural ability led to his being devoted to the profession of a minister of religion. Priestley tells us in his "Autobiography," that he generally found himself on the unorthodox side. He passed from Calvinism to Arianism; and finally, in middle life, landed in that very broad form of Unitarianism by which his craving after a credible and consistent theory of things was satisfied.

On leaving Daventry, Priestley became minister of a congregation, first at Needham Market, and secondly at Nantwich; but whether on account of his heterodox opinions, or of the stuttering which impeded his expression of them in the pulpit, little success attended his efforts in this capacity. In 1761 a career much more suited to his abilities became open to him. He was appointed "tutor in the languages" in the Dissenting Academy at Warrington. It is interesting to observe that, as a teacher, he encouraged and cherished, in those whom he instructed, the freedom which he had enjoyed in his own student days.

At the conclusion of his lectures, he always encouraged his students to express their sentiments relative to the subject of it, and to urge any objections to what he had delivered, without reserve. It would be difficult to give a better descrtption of a model teacher than that conveyed in these words.

From his earliest days Priestley had shown a strong bent toward the study of Nature; and his brother Timothy tells that the boy put spiders into bottles to see how long they would live in the same air—a curious anticipation of the investigations of his later years. At Nantwich, where he set up a school, Priestley informs us that he bought an air pump, an electrical machine, and other instruments, in the use of which he instructed his scholars. But he does not seem to have devoted himself seriously to physical science until 1766, when he had the great good fortune to meet Benjamin Franklin, whose friendship he ever afterward enjoyed. Encouraged by Franklin, he wrote a "History of Electricity," which was published in 1767, and appears to have met with considerable success.

The first outcome of Priestley's chemical work, published in 1772, was of a very practical character. He discovered the way of impregnating water with an excess of

"fixed air," or carbonic acid, and thereby producing what we now know as "soda-water"—a service to naturally, and still more to artificially thirsty souls, which those, whose parched throats and hot heads are cooled by morning draughts of that beverage, can not too gratefully acknowledge. In the same year Priestley communicated the extensive series of observations which his industry and ingenuity had accumulated, in the course of four years, to the Royal Society, under the title of "Observations on Different Kinds of Air"—a memoir which was justly regarded of so much merit and importance, that the society at once conferred upon the author the highest distinction in their power, by awarding him the Copley Medal.

In 1771 a proposal was made to Priestley to accompany Captain Cook in his second voyage to the South Seas. He accepted it, but the appointment lay in the hands of the Board of Longitude, of which certain clergymen were members, and they objected to Priestley, "on account of his religious principles."

In 1780 Priestley settled in Birmingham, and was soon invited to become the minister of a large congregation. This settlement Priestley considered at the time to be "the happiest event of his life." And well he might think so, for it gave him competence and leisure; placed him within reach of the best makers of apparatus of the day; made him a member of that remarkable "Lunar Society" at whose meetings he could exchange thoughts with such men as Watt, Wedgewood, Darwin, and Boulton; and threw open to him the pleasant house of the Galtons of Barr, where these men, and others of less note, formed a society of exceptional charm and intelligence.

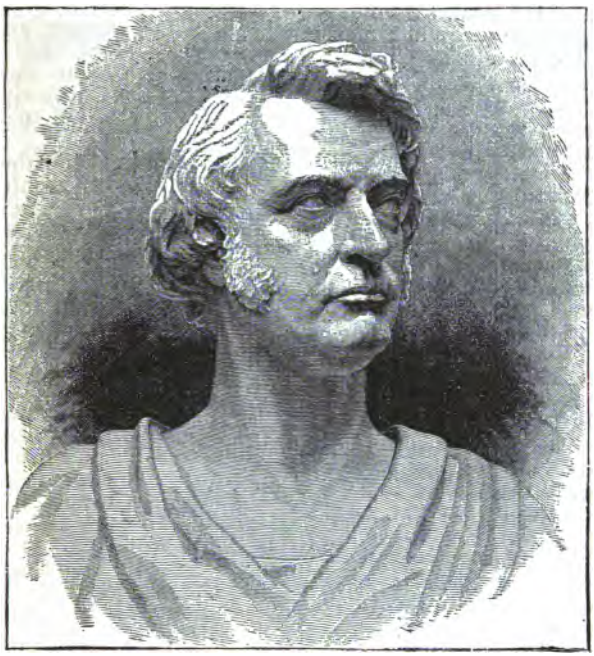
But these halcyon days were ended by a bitter storm. The French Revolution broke out. In 1791 the celebration of the second anniversary of the taking of the Bastile by a public dinner, with which Priestley had nothing whatever to do, gave the signal to the loyal and pious mob, who, unchecked, and indeed to some extent encouraged, by those who were responsible for order, had the town at their mercy for three days. The chapels and houses of the leading Dissenters were wrecked, and Priestley and his family had to fly for their lives, leaving library, apparatus, papers and all their possessions, a prey to the flames.

Priestley never returned to Birmingham. He bore the outrages and losses inflicted upon him with extreme patience and sweetness, and betook himself to London. But even his scientific colleagues gave him a cold shoulder; and, though he was elected minister of a congrega-

tion at Hackney, he felt his position to be insecure, and finally determined on emigrating to the United States. He landed in America in 1794; lived quietly with his sons at Northumberland, in Pennsylvania, where his posterity still flourish; and, clear-headed and busy to the last, died February 6, 1804.

Such were the conditions under which Joseph Priestley did the work which lay before him, and then, as the Norse Sagas say, went out of the story. The work itself was of the most varied kind. No human interest was without its attraction for Priestley, and few men have ever had so many irons in the fire at once; but, though he may have burned his fingers a little, very few who have tried that operation have burned their fingers so little. He made admirable discoveries in science; his philosophical treatises are still well worth reading; his political works are full of insight and replete with the spirit of freedom; and, while all these sparks flew off from his anvil, the controversial hammer rained a hail of blows on orthodox priest and bishop. While thus engaged, the kindly, cheerful doctor felt no more wrath or uncharitableness toward his opponents than a smith does toward his iron. But if the iron could only speak!—and the priests and bishops took the point of view of the iron.

No doubt what Priestley's friends repeatedly urged upon him—that he would have escaped the heavier trials of his life and done more for the advancement of knowledge, if he had confined himself to his scientific pursuits and let his fellow-men go their way—was true. But it seems to have been Priestley's feeling that he was a man and a citizen before he was a philosopher, and that the duties of the two former positions are at least as imperative as those of the latter. Moreover, there are men (and I think Priestley was one of them) to whom the satisfaction of throwing down a triumphant fallacy is as great as that which attends the discovery of a new truth; who feel better satisfied with the government of the world, when they have been helping Providence by knocking an imposture on the head; and who care even more for freedom of thought than for mere advance of knowlege. These men are the Carnots who organize victory for truth, and they are, at least, as important as the generals who visibly fight their battles in the field.



CHARLES SUMNER.—(FROM MILMORE'S BUST.)

CHARLES SUMNER.

THE year 1874 was sorrowfully distinguished by the loss of this eminent statesman, who fell a victim to disease while in the active discharge of his duties as Senator of the United States. He was born in Massachusetts, January 6, 1811, and died at Washington, March 11, 1874. He ranks among the greatest of men. The memory of his remarkable abilities, noble character, and life-long labors of patriotism, will be ever remembered.

It would be impossible within the brief space here allotted to give anything like a full sketch of a life so full of great achievements as that of Sumner. A full and interesting summary may be found in the eulogy pronounced by George Wm. Curtis, delivered in Boston before the Legislature of the State of Massachusetts, June 9, 1874. We make therefrom the following extracts:

"The Puritan spirit, in the larger sense, enriched with many nationalities, broader, more generous, more hu-

mane, is the master influence of American civilization, and among all our public men it has no type so satisfactory and complete as Charles Sumner. He was the son of Massachusetts. By the fruit let the tree be judged. The State to whose hard coast the 'Mayflower' came, and upon whose rocks it dropped its seed—the State in which the mingled Puritan and Pilgrim spirit has been most active—is to-day the chief of commonwealths. It is the community in which the average of well-being is higher than in any State we know in history. Puritan in origin though it be, it is more truly liberal and free than any similar community in the world. The fig and the pomegranate and the almond will not grow there, nor the nightingale sing, but nobler blossoms of the old human stock than its most famous children the sun never shines upon; nor has the liberty-loving heart of man heard sweeter music than the voices of James Otis and Samuel Adams, of John Adams and Joseph Warren, of Josiah Quincy and Charles Sumner. Surely I may say so, born in the State that Roger Williams founded—Roger Williams, the prophet whom Massachusetts stoned.

"Into this State and these influences Charles Sumner was born sixty-three years ago, while as yet the traditions of colonial New-England were virtually unchanged. Here were the town-meeting, the constable, the common school, the training day, the general intelligence, the morality, the habit of self-government, the homogeneity of population, the ample territory, the universal instinct of law. Here was the full daily practice of what De Tocqueville afterward called the two or three principal ideas which form the basis of the social theory of the United States, and which seemed to make a republic possible, practicable, and wise. It was one of the good fortunes of Sumner's life that, born amidst these influences, he used to the utmost the advantage of school and college. To many men youth itself is so sweet a siren that in hearing her song they forget all but the pleasure of listening to it. But the sibyl saved no scroll from Sumner; he had the wisdom to seize them all. His classmates, gayly returning late at night, saw the studious light shining in his window. The boy was hard at work already, in those plastic years storing his mind and memory, which seemed indeed an 'inability to forget,' with the literature and historic lore which gave his later discourse such amplitude and splendor of illustration that, like a royal robe, it was stiff and cumbrous and awkward with exaggerated richness of embroidery. He never lost this vast capacity of work, and his life had no idle hours. Long afterward, when in Paris,

recovering from the blow in the Senate, he was ordered not to think or read, and daily, as his physician lately tells us, undergoing a torture of treatment which he refused to mitigate by anæsthetics, simply unable to do nothing, he devoted himself to the study and collection of engravings, in which he became an expert. And I remember in the midsummer of 1871, when he remained, as was his custom, in Washington, after the city was deserted by all but its local population, and when I saw him daily, that he rose at seven in the morning, and with but a slight breakfast at nine, sat at his desk in the library hard at work until five in the afternoon. It was his vacation: the weather was tropical; and he was sixty years old. The renowned Senator at his post was still the solitary midnight student of the college."

MORITZ HERMANN VON JACOBI.

THE death of this eminent scientist took place on March 10th, 1874, at St. Petersburg, Russia. He was born at Potsdam, Prussia; but his life was mainly spent in Russia, where his many important discoveries in the application of galvano-electricity to industrial purposes were made. He constructed a short line of telegraph in St. Petersburg in 1830, and ten years afterward his book, entitled *Die Galvanoplastik*, was published. He was for a long time associated with Klein in the investigation of the electro-deposition of iron, and he suggested to the Czar Nicholas the formation of a regiment of galvanic engineers, to be trained in the management of electricity. This idea was carried out and the learned doctor was made colonel of the galvanic regiment.

He constructed in 1834 the first electro-magnetic engine that was anything more than a model, and in 1838 he used it to propel a boat containing ten or twelve persons on the Neva. She was fitted with paddle-wheels, and a speed of four miles an hour was maintained for several days. The power was supplied by a battery on the Grove principle, of 64 platinum plates, each having 36 square inches of surface.

DR. FRANCIS EDMUND ANSTIE, a well-known physiologist and physician, is added to the list of those who have fallen martyrs in the cause of scientific research, his death, on the 12th of September, 1874, having taken place, after an illness of only four days, in consequence of a dissection wound inflicted while he was investigating the origin of a serious and somewhat mysterious disease which had prevailed in a school at Wandsworth.

DR. J. P. JOULE, F.R.S., OF MANCHESTER, ENG.

DR. J. P. JOULE, F.R.S., OF MANCHESTER, ENG.

IF the discovery of chemical analysis by means of the spectrum be accepted as the most brilliant scientific achievement of the present century, the research by which the conservation of energy became established on a basis of exact quantitative experiment, must be regarded as far more profound and important in its consequences. This great generalization, beyond doubt, is the property of no single intellect. Many men, in different countries, had independently arrived at the conception, and had furnished various kinds and degrees of evidence that it was true, but the honor of its first experimental demonstration, by which the quantitative convertibility of forces may be established, belongs to the subject of the following sketch.

James Prescott Joule was born at Salford, England, on Christmas-eve, 1818, and was privately educated at

home. He early showed a taste for scientific study, and, at the age of fifteen, became a pupil of Dr. John Dalton, the chemist. This celebrated man—atomist and Quaker—came to Manchester, and became Professor of Mathematics and Natural Philosophy in the new college; and, when that was removed to York, he remained as a private teacher of the same subjects. By him, young Joule was initiated into mathematics, and trained in the art of experiment.

Dr. Joule's attention was early turned in a direction which naturally led him to his great discovery. At an early age he took up the subject of electro-magnetic engines; the idea of using electricity as a motive power being then a favorite one among scientific men. He made inventions to employ electro-magnetic force as a motor, and his first scientific paper was upon this subject. But the result of his investigations was the abandonment of any expectation of obtaining a valuable power from electro-magnetism. But, while giving up the hope of arriving at any important economical conclusions, Dr. Joule continued his researches on the laws which govern the lifting and sustaining power of the electro-magnet. Early in 1841 he gave, in the form of a lecture in the Royal Victoria Gallery, Manchester, the result of his experiments on a new class of magnetic forces, with the preliminary statement of what had been done by M. Jacobi, of St. Petersburg, and himself, in the way of applying magnetism as a motive power. M. Jacobi, it may be remarked, is reputed to have been the first who constructed an electro-magnetic machine capable of producing continuous movement, and which was for a long time used in impelling a boat on the Neva.* Dr. Joule subsequently continued this investigation in conjunction with Dr. Scoresby, and from the results of their calculations it appeared that a grain of coal consumed by a steam-engine will raise 143 pounds one foot high, while a grain of zinc consumed in a voltaic battery can raise theoretically only 80 pounds. The cost of power by electro-magnetism was estimated to be twenty-five times greater than the cost of an equal amount of steam-power. Dr. Joule had arrived at the theory of the magnetic engine when twenty-one years of age, and in 1840 he had published a paper in Sturgeon's "Annals of Electricity," demonstrating that there is no variation

* Since Jacobi's elaborate experiments, many other electro-motors have been constructed. The late Mr. Sturgeon, of Manchester, with whom Mr. Joule corresponded in his early inquiries, pumped water with an electro-magnet; Mr. Davidson, of Aberdeen, drove a turning-lathe by the same power; and in 1848 Sir David Brewster sailed at the rate of a mile an hour in a boat thus impelled, and constructed by Mr. Dilwin, of Swansea.

in economy, whatever the arrangement of the conducting metal, or whatever the size of the battery. Kindred to the subject of electro-motive machines is that of the air-engine, to which Mr. Joule gave considerable attention.

Dr. Joule has pursued several lines of inquiry conjointly with other philosophers. Dr. Lyon Playfair and Dr. Joule published an account of a conjoint investigation into the volumes occupied by bodies, both in the solid form and when dissolved in water, and have obtained results of an unexpected nature as well as of great value. Among other curious results, they found that "many salts, when dissolved in water, do not add to the bulk of the water more than is due to the water actually present in the salts." They have further shown that "when salts do add to the bulk of the water in which they are dissolved, the increase of the bulk corresponds to that of a volume, or some multiple of a volume of water."

Dr. Joule's inventive talent was early shown in the construction of galvanometers. In 1863 he described to the Manchester Society his new and extremely sensitive thermometer, which was able to detect the heat radiated by the moon. When the moonbeam passed gradually across the instrument, the index was deflected several degrees, first to the right and then to the left; thus showing that the air in the instrument had been heated a few ten-thousandths of a degree by the influence of the rays. These experiments were lately referred to by the present Earl Rosse, in a lecture on the same subject delivered at the Royal Institution.

It was about 1840 that Dr. Joule began to direct his especial attention to the subject of heat. He made a communication to the Royal Society in that year, announcing the discovery of a principle in the development of heat by the voltaic principle, in which he established relations between heat and chemical affinity.

Some two years later, he applied the dynamical theory to steam engines, to electro-magnetic engines, to vital processes, and to chemistry. His paper on the "Electric Origin of Heat" was a first communication, in 1842, to the meeting of the British Association at Manchester—the last meeting, by the way, at which Dalton appeared; and on August 21, 1843, a circumstance which requires special mention, he communicated a second paper to the Association, then meeting at Cork, in which he describes a series of experiments on magneto-electricity, executed with a view to determine the mechanical value of heat. Experiments, with a like object, on the condensation of air, were communicated to the Association in 1844; and in

1845 his important paper, "On the Mechanical Equivalent of Heat," detailed the results he had gained from water agitated by a paddle-wheel. In the following years, the same subject was perseveringly prosecuted, by numerous and yet more accurate experiments, until his grand determination was finally reached. In an elaborate paper, read before the Royal Society, January 21, 1849, and published in the "Philosophical Transactions" of 1850, we have the results thus stated: 1. The quantity of heat produced by the friction of bodies, whether solid or liquid, is always proportional to the quantity of force expended. 2. The quantity of heat capable of increasing the temperature of a pound of water by 1° Fahr., requires for its evolution the expenditure of a mechanical force required by the fall of 772 pounds through the space of one foot.

Dr. Tyndall gives the following explanation of the term "foot-pounds," used as a measure by Joule: "The quantity of heat which would raise one pound of water one degree in temperature is exactly equal to what would be generated if a pound weight, after having fallen 772 feet, had its moving force destroyed by collision with the earth. Conversely, the amount of heat necessary to raise a pound of water one degree would, if applied mechanically, be competent to raise a pound weight 772 feet high, or it would raise 772 pounds one foot high. The term 'foot-pound' expresses the lifting of one pound to the height of a foot. Thus the heat required to raise the temperature of one pound of water one degree being taken as a standard, 772 foot-pounds constitute what is called *the mechanical equivalent* of heat."

For this great scientific achievement, the Royal Medal of the Royal Society was awarded to Dr. Joule in 1852; and eight years later, when men of science began more fully to apprehend the great value of the discovery, he was presented also with the Copley Medal of the Royal Society.

Dr. Joule has figured but little in the fields of popular science, having only given a few lectures to the people in Manchester, and published no book, as we are aware, of any kind. But his contributions to scientific periodicals and the transactions of learned societies are very numerous, and give the results of prolonged and incessant original investigations, extending through many years.

CHIEF JUSTICE WAITE.

THE CHIEF JUSTICE OF THE UNITED STATES—MORRISON R. WAITE.

MORRISON R. WAITE, appointed in 1874 by President Grant to be Chief-Justice of the United States, was born at Lyme, Connecticut, November 29, 1816. His father, Henry M. Waite, was one of the judges of the Supreme Court of Errors of the State, and afterward Chief Justice. The son graduated at Yale College in 1837, and, after studying law one year in his father's office, removed to Maumee City, Lucas County, Ohio, in 1838, and in the following year was admitted to the bar in that State. He continued to practice law in Maumee City till 1850, when he removed to Toledo, where he now resides, and devoted himself closely to his profession.

His practice became large and lucrative, and it suffered but two interruptions, once in 1849–50, when he was a member of the Ohio House of Representatives for one term, and again in 1872, when he was called to act as a counsel for the Government in the Geneva Arbitration.

At the time of his nomination to the position of Chief

Justice, Mr. Waite was president of the Convention called to revise the Constitution of Ohio, to which post he was chosen by the unanimous vote of both parties. He has for many years stood at the head of the bar in his adopted State, and twice declined a seat on the bench of the Supreme Court.

JOSEPH HARRISON.

JOSEPH HARRISON, of Philadelphia, Pa., well known in engineering circles as one of the greatest American mechanics, died in that city, 1874. Born in 1810, he showed proficiency at a very early age, and served as apprentice, journeyman, and foreman till he was 25 years old, and was then in the employ of Garrett & Eastwick, in Philadelphia, where he designed and built a locomotive. Mr. Harrison went to St. Petersburg in 1843. Mr. Thomas Winans, of Baltimore, who had gone there to superintend the working of a locomotive, united with Mr. Harrison in making contracts which were ultimately awarded to them, under the firm of Harrison, Eastwick & Winans. They constructed 162 twenty-five ton locomotives; 2,000 eight-wheel cars; 500 eight-wheel platform cars; 70 eight-wheel passenger cars on the American plan; 6 eight-wheel post-cars: the total of the contract amounting to $3,000,000. All this work was constructed in government shops, at St. Petersburg, by Russian workmen, and was completed in five years. Mr. Harrison's high personal character obtained for him the means of carrying out this large contract on his very small capital; and after this great success and many others, he returned to Philadelphia in 1852, since when his greatest work has been the production of the Harrison boiler, one of the most highly esteemed of several inventions, which defeat the danger of explosion of boilers by building them in sections.

He also introduced into Europe the American drop-bottom cupola, for iron smelting, the smelters having previously, at the end of the heat, pulled the slag, etc., from a small door or the tap-hole, instead of dropping the bottom, as is now done. He patented the equalizing beam for distributing equally the weight of the locomotive on the drivers, and the Harrison stub end (without keys) for the connecting rods. He designed and first used the tool for boring both the crank pin holes at right angles at the same time, thus doing the work mechanically correct as well as much cheaper.

The integrity and moral courage of this eminent man laid the foundation of his success and his great fortune; and those who knew him, whether as a husband, father, son, friend, or citizen, will sincerely mourn his death.

JAMES LICK.

THIS generous Californian was among the earliest settlers in the Golden State. From a biographical sketch recently published in San Francisco, we learn that Mr. Lick, while still a very young man, went from his home in Pennsylvania to South America, where we soon hear of him in the pampas of Brazil and Buenos Ayres, with thousands of horses and cattle, in the capacity of a great proprietor, from whom the governments of those countries derived their supplies for the cavalry and their commissariat. Again we find him on the other side of the continent, operating actively yet unobtrusively in the commercial centres of Chili and Peru.

When the news of the gold discovery in California reached him, he was in business that would have taken an ordinary man a series of months, at least, to so close up that he could leave it with any sort of consistency; yet he put doubloons enough in his trunk to make $20,000 besides the expenses of the trip, intrusted his business to a confidential friend, and stepped on board the first vessel leaving his place for San Francisco. Arriving there, he found a splendid opportunity to invest in real estate. He scanned the situation, foresaw the growth of the town, selected his "corner lots" with great good judgment, and invested his money. The property he then purchased with $20,000 is perhaps to-day worth many millions. In the first few years he built sparingly and with great care; afterward, liberally and magnificently. These operations; and numerous others, proved very remunerative.

Such, in brief, is the history of the man who has just given nearly the whole of his large fortune to charitable and educational purposes. It is one of the most munificent gifts for the public benefit on record, as witness the following tabular statement:

Observatory, summit of the Sierra	$700,000
School for the Mechanic Arts	300,000
Bronze statuary, Sacramento	250,000
Key Monument, San Francisco	150,000
Baths, San Francisco	150,000
Old Ladies' Home, San Francisco	100,000
Ladies' Protection and Relief Society, San Francisco	25,000
Protestant Orphan Asylum, San Francisco	25,000
Orphan Asylum, San José	25,000
Mechanics' Library, San Francisco	10,000
Society for the Prevention of Cruelty to Animals, San Francisco	10,000
To Academy of Sciences and Pioneer Society, San Francisco, residue of estate—perhaps	255,000
Total	$2,000,000

JOHN ROACH.

THE name of John Roach is little known outside of commercial circles, but he is a man deserving of high honor for what he has accomplished towards the restoration of American commerce. He was born in Ireland. His father died when he was but twelve years old, leaving him to make his way in the world by the aid of native pluck and mother-wit. At the age of sixteen he was induced to come to this country. Without friends, and almost penniless, he sought employment at anything he could find, in order to provide himself with means to return to Ireland. But work was scarce, and after remaining several days in New-York he set out for a place in Southern New-Jersey, where he learned a man was living who formerly worked for his father.

He crossed the ferry with a few shillings in his pocket, and after traveling on foot some sixty miles, found the party he was in search of at a place known as the Howell Works, where a blast-furnace belonging to James P. Allaire was in operation. Here he obtained work of a promiscuous character, connected with making iron from the ore and coal from wood, at seven dollars per month wages and board. There was also a department in these works where a variety of rough castings were made directly from the blast-furnace without remelting, the labor for making them being paid for by the piece. The custom existed of requiring fifty dollars for an opportunity to learn this branch of the business. If unsuccessful, no pay was received, and the fifty dollars forfeited. At the end of the first year he had saved the requisite amount, paid it, and commenced in this department, succeeding as well as he had anticipated, while many others failed. By industry, long hours and rigid economy, at the end of three years he had saved some fifteen hundred dollars, when the furnace stopped, and all work was suspended.

There were no savings-banks in that section of the country at that time, and his savings were all in Mr. Allaire's hands. He drew from him a small amount, and went West to purchase some land, with the understanding that when his arrangements were made, and the land purchased, the balance was to be remitted to him.

In the meantime Mr. Allaire failed in business, and John Roach's savings were all gone. He again found himself without money, and was compelled to work on the canals and railroads then constructing in that part of the country, in order to return to New-York.

On his arrival in this city he went to the Allaire Works, and commenced learning to make castings for marine en-

gines and ship-work at one dollar per day. While learning this branch of the business he also gave much attention to the other branches, and gathered information from every source within his reach. Here he worked for many years. He had married while receiving a low salary, and even when this was increased he found it barely sufficient to support his family; the hard toil and constant effort to maintain the struggle for support affected his health, and he longed to establish a business of his own. By occasional work over-hours he succeeded in saving a hundred dollars, which, with three partners who had each the same amount, he invested in a foundry. His partners soon became discouraged and sold out to him, and thus he became the sole proprietor of the establishment. He did so well in his business that in four years he saved $30,000. With this capital he purchased the ground on which his foundry stood, erected better buildings, procured new and improved appliances, and looked forward to a still more prosperous career. But soon afterward his foundry was entirely destroyed by the explosion of a boiler; he was unable to recover the insurance, and after paying his debts found himself again without a dollar he could call his own.

Undiscouraged by this heavy misfortune, he at once repaired his shop for temporary use, and started again, with no assistance but a clear head and good credit. He was soon able to rebuild his foundry, and gradually increased its capacity. Here the engines of the ships "Dunderberg," the "Bristol," and "Providence," were constructed, the largest ever built in this country.

After the war, the American ship-building interest was so depressed that many of the large firms engaged in that business were disposed to abandon it. Mr. Roach purchased the Morgan Iron Works, the Neptune, the Franklin Forge, and the Allaire Works, where he had served his time, and concentrated the best machinery in each at the Morgan Works. In November, 1871, he bought of Messrs. Rainey & Sons their large ship-yards at Chester, Pennsylvania, as a part of his avowed purpose to restore American shipping to the place it held before the war of the rebellion crippled our commerce and drove all ship-building to the banks of the Clyde. During the past two years the amount of shipping built in the Chester yards is more than 40,000 tons. His latest triumphs are the "City of Peking," and the "City of Tokio," built for the Pacific Mail Steamship Company. Mr. Roach asserts that he can build a better ship for the same money than can be built in any European ship-yard, and he declares that if others will go into the fight with him, he will make the banks of

the Delaware the great ship-building yard of the whole world.

It was this union of success in the past and determination for the future that was honored by a complimentary banquet and presentation of a heavy silver service at Delmonico's, in this city, on the evening of April 30th, 1874. Commercial men, politicians, journalists, and many well-known professional men were at the presentation, and spoke with the highest praise of Mr. Roach's achievements. On another page will be found his portrait, taken from a recent photograph. (12)

PROFESSOR AGASSIZ.

THIS distinguished naturalist and scientific observer died at Cambridge, Mass., Dec. 14, 1873, aged 66 years. Up to within a few days of his decease he had enjoyed fine health, and was in the midst of his usual duties, in connection with Harvard University and the Natural History School of Penikese, when he was stricken down. He was attended during his illness by the most eminent physicians, among whom was Dr. E. Brown-Séquard. An account of the autopsy will be found on another page of this volume. A portrait of Prof. Agassiz, as he appeared in the full vigor of natural life, is given on page 387 of our SCIENCE RECORD for 1872.

Louis John Rudolph Agassiz was born in Motiers, Switzerland, May 28, 1807, his father and ancestors for six generations being clergymen. At the University of Munich, he commenced his studies in embryology, receiving instructions from Wagler, Oken and Martins, and issued his first publications—brief treatises on special subjects. Becoming a favored pupil of Cuvier, and associating with such men as Owen, Milne-Edwards, and others, he laid the basis for his establishment of fossil ichthyology, and its translation to a cognate science. Aided by Baron Von Humboldt, he published his great work, in which about 1000 species are fully described and 700 more partially so, and thus firmly established his fame as a naturalist. Then came the enunciation of his glacial theory, now an accepted scientific fact. In 1846, he came to this country, and became connected with the United States Coast Survey. Accepting the chair of zoölogy and geology in Harvard College, he began the endeavors which have culminated in the establishment of the Cambridge museum (the most extensive of its kind in the world) and the education of scores of able and learned students of natural science. As an opponent of the Darwinian theory, Agassiz has drawn the attention of the entire world.

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